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1 The Indian Energy Sector

In 1998-99, commercial energy consumption in India was estimated at 195.11 mtoe (million tonnes of oil equivalent), indicating a 75% growth over a decade. Nevertheless,

India's per capita consumption of commercial energy continues to be much lower than the global average of about 1684 kgoe (kilograms of oil equivalent), and just a fraction 5% - 10% that of developed countries like Japan, France and USA. India's per capita consumption of electricity is just one-sixth of the global average (World Bank 2000).

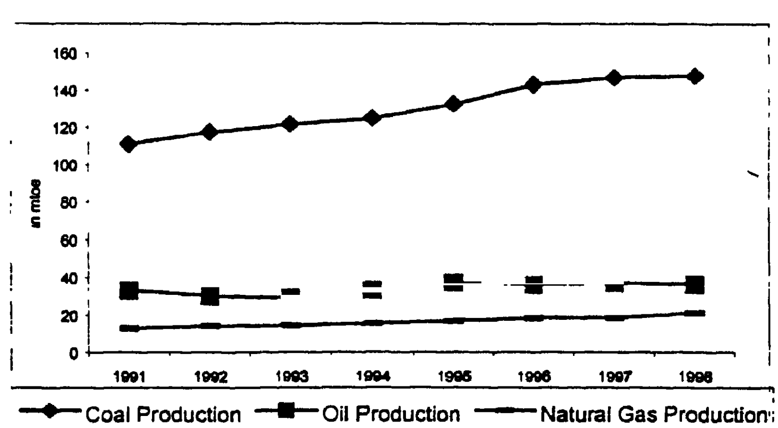
Energy Supply

Table 1. Energy Supply Indicators - 1999/2000

Reserves / Production	Coal	Oil	Gas	Power
Reserves / Installed capacity	211593.6 MMT[1]	715 million tonnes	675 billion cubic metres	97837 MW
Production / generation	292.27 MMT	32.72 million tonnes [2]	27.43 billion cubic metres [3]	451 billion units

1 Coal reserves upto depth of 1200 metres
2 Crude Oil production only, petroleum products production 64.55 million tonnes
3 Gross production - includes flaring etc

Figure III. Trends in production of coal, oil and natural gas



Source. BPASR 1999

India is the third largest producer of coal, housing nearly seven per cent of the world's coal reserves. Of the total reserves of 211593.6 MT up to depth of 1200 metres, 80% are non-coking (Table 1). Indian coal generally has low calorific value and high ash content. With increased mining – particularly opencast mining – the quality of coal tends to deteriorate further.

In the oil and natural gas sector, despite a continuous decline in India's balance recoverable reserves, India continues to be one of the least explored regions with just 30% of its prognosticated reserves explored so far.

Over the years, domestic availability of crude and petroleum products has not kept pace with consumption. But in and after 2000/2001, the situation for petroleum products is expected to improve considerably with additions to refining capacity. The growing demand for natural gas will have to be met from imports in the form of LNG (liquefied natural gas).

India's power sector draws upon coal and petroleum products as well as the country's resources of uranium, wind energy and hydropower. India has 34 000 tonnes uranium resources of which only 44% is economically exploitable. The total potential of small hydro (up to 15 MW capacity) and wind energy in the country is estimated at 10 000 MW and 65 578 MW respectively.

The total installed capacity of power in India as on 31 March 2000 was 97837 MW, comprising 24% hydro, 71% thermal, 3% nuclear and 1% wind. Despite growth in power generation over the years, India continues to face power shortages. The quality of power too continues to be poor. Voltage fluctuations, frequency problems and supply interruptions are rampant.

There are concerns attached to the key sources of power — coal and hydel. Thermal power generation from coal is limited by the quality of coal, transportation constraints , and environmental concerns. Though hydel power seems to be the best option, most of the unexploited potential is located in difficult/inaccessible areas and socio-political issues such as inter-state co-operation and dislocation need to be tackled.

Given the growing concerns about climate change and the depleting fossil fuel reserves, increased use of renewable sources of energy has become imperative. The potential for renewable energy technologies – biogas, improved cookstoves, biomass, solar energy, wind energy, small hydropower, ocean energy, and energy from urban, municipal and industrial wastes – is immense. Currently, India's renewable energy programme is one of the world's largest and most diverse. Grid quality power from renewables is now a reality. In fact, installed capcity of power based on renewables represent over 1.5% of the total installed capcity of power. Of these, wind is the most important and India's wind power capacity of 1080 MW is the fifth largest in the world.

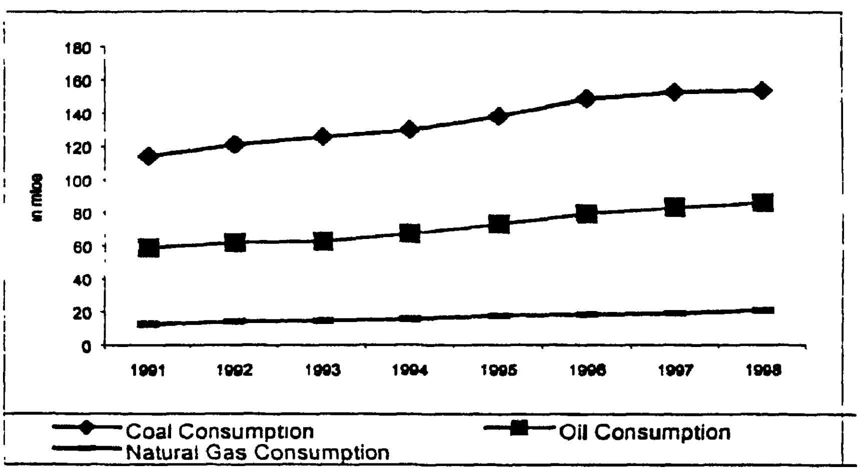
In addition to commercial fuels – coal, oil, natural gas and power – India also consumes large quantities of traditional fuels. The traditional energy sector is not well documented, but it is estimated as meeting as much as 40% of the country's total energy requirements.

Energy consumption

India's commercial energy consumption is just one-fourth that of the world average. It is not surprising, therefore, that India's consumption of coal, oil and natural gas is a small part of world consumption.

The consumption of commercial fuels is steadily rising throughout the Indian economy, with coal continuing to be the most prominent energy source (Figure IV).

Figure IV. Trends in consumption of coal, oil and natural gas



Source. BPASR 1999

Table II. Sectoral energy consumption by fuel: 1998/99

Sector	Coal (%)	Petroleum products (%)	Natural gas (%)	Power (%)	TOTAL (%)
Agriculture	0	10	1	89	100
Industry	73	13	3	11	100
Transport	0	99	1	0	100
Domestic	0	72	1	27	100
Others	0	71	17	12	100

Energy security

The demand for energy in India has been growing rapidly and India continues to be a net importer of energy. India imported 39.81 million tonnes of oil and 17.38 million tonnes (net imports) of petroleum products in 1998/99. India is also

expected to import natural gas to meet its growing gas requirements. Projections of crude imports indicate that import dependence which is 66% at present will rise to 80% by 2010.

On the supply side too several developments have been worrisome. With reserves declining in other parts of the world, the Gulf region is likely to emerge with a much larger share of global oil supplies than in the past. According to a study, the share of imports of East Asia from the Middle East will rise from 70% in 1993 to 87% in 2000 and will be as high as 95% in 2010 (Fesharaki et.al. 1995). Given the high incidence of political turmoil in this region, energy supply irregularities seem imminent.

The Caspian basin could have been an alternative source of hydrocarbon supplies. But this region is landlocked and no pipeline infrastructure is in place yet for import of these energy resources.

Evidently, the issue of energy security looms large. Nevertheless, some developments in the Gulf region are encouraging. As more and more private oil and gas companies invest in this region, it is hoped that the diversity of suppliers would result in more competition in the industry. Also producers and consumers are now being integrated with suppliers making downstream investments in consuming countries. These developments are likely to bring about more stability in supplies and prices.

Energy security is not limited to ensuring smooth supplies of energy at reasonable prices. It also entails production and use of energy in a manner that it is least damaging to the environment and promotes sustainable development.

Energy - environment interface

The environmental implications of energy use arise primarily out of the fact that world-wide, nearly 90% of the primary energy consumption comes from combustion of fossil fuels. Utilization of less polluting renewable energy forms has been relatively low. The most direct impact of fossil fuel use is an increase in air pollution levels, particularly in urban areas with expanding vehicular population. Use of fossil fuels also produces greenhouse gases, increasing the threat of global warming.

Without a major global effort to curtail carbon dioxide emissions, these emissions are expected to double from pre-industrial levels before 2100. In response the earth's average surface temperature is expected to warm up by 1° C to 3.5° C over this century – a more rapid change in climate than has occurred for the last 10 000 years (WRI 1998).

The data below are indicative of the environmental problems that India is faced with.

- *Air pollution :* Estimated pollution due to motorised transport in 1997 was 68 times that in 1947 and particulate matter in air in 60 out of 62 cities exceeded WTO guidelines (TERI 1998).
- *Water Pollution :* A survey of 22 industrialised zones conducted by the Centraol Pollution Control Board (CPCB) revealed that groundwater quality in all these zones was contaminated with heavy metals, chemicals and coliform bacterial and found unfit for drinking. River water too in most parts of the country is highly polluted in terms of biochemical oxygen demand and coliform bacteria.
- *Solid waste* including hospital waste : Between 1947 and 1997, there was an eightfold increase in solid waste generated in Indian cities. Over one-fourth of this solid waste is not collected at all.
- *Industrial / hazardous waste* : The industrial sector generates about 100 million tonnes of non-hazardous solid waste and 2 million tonnes of hazardous waste annually.
- *Climate Change :* In 1990 Carbon dioxide emissions from India were around three per cent of global equivalent emissions, of which about 55% were from the energy sector (road transport, burring biomass fuels, coal mining, and fugitive emissions from oil and gas).
- *Biodiversity:* nearly 23% of India's animal species have become extinct.
- *Soil degradation*: Over 24,000 ha (hectares) of India's forest cover are lost every year, and 25% of the country's area is under threat of desertification.

Several measures have been taken up for environmental management. These include setting up of standards and regulations for ambient air quality, drinking water, industrial emissions, vehicular emissions, industrial effluent discharge, hazardous waste and bio-medical waste. Areas that are being addressed include municipal solid waste and recycled plastic usage.

Measures in the area of vehicular pollution abatement include use of less polluting fu7els including low sulphur diesel, unleaded petrol and compressed natural gas (CNG); vehicles with catalytic converters; and regulated movements of trucks.

The Road Ahead

Over the 1990s, there has been a flurry of regulatory reforms in the Indian energy scene. While coal prices have been deregulated, the administered pricing mechanism is being dismantled in the oil & gas sector. The power sector has witnessed initiatives towards unbundling and gradual corporatization of state electricity utilities and the setting up of regulatory commissions. There has been increased private participation in all sectors.

Managing rapid energy demand escalations through rational energy pricing, more efficient energy production and utilization, taxation and rationing is a must. Costs of environmental degradation will have to internalized, and environmental and socio-economic impact assessment will need to be built into project planning and development.

These efforts will have to be accompanied by fuel substitution initiatives that reduce dependence on oil imports and favour greater use of indigenous energy resources. Resources that could be taken up for substitution include abundantly available indigenous resources - of renewable energy and coal. India is perhaps, the only country in the world with an independent ministry for the promotion of renewable energy technologies (RETs). The thrust of India's renewable energy programmes has been on market development in order to facilitate and catalyze commercialization. This has resulted in rapid increases in the diffusion of RETs. The increased use of coal would be possible if coal gasification technology is used extensively and the commercial use of fly-ash is encouraged.

A policy shift towards relatively less energy-intensive industries would also help mitigate, to an extent, the concerns of energy security. The emergence of India as a front runner in information technology is a positive step in this direction.

Organization of the energy sector

Traditionally, the Indian energy sector has been regulated and owned by governmental agencies and organizations. The dominant role of the Union Government in the energy sector can be traced to the Seventh Schedule of the Constitution of India, which provides a list of subjects reserved for the Union. Energy-related subjects in the Seventh Schedule include:

- Atomic energy and mineral resources necessary for its production
- Regulation and development of oil fields and mineral oil resources, and petroleum and petroleum products
- Regulation of mines and mineral development as declared by the Parliament
- Regulation of labour and safety in mines and oil fields
- Regulation and development of inter-state rivers.

Evidently, the states have had no role in the regulation, promotion, or conservation of atomic, petroleum or coal-based energy sources. Their involvement has been limited to the electricity sector (the only energy-related subject in the concurrent list) and more recently in the promotion of NRSE (new and renewable sources of energy).

The organizational framework of the Union Government and related governmental agencies in the energy sector is depicted in Figure 1. A multitude of ministries, organizations, and agencies are vested with various functions geared towards ensuring sustainable energy development.

Overall energy development

At the national level, three forums for coordinated planning and thinking for energy development have been identified. First, the Parliament and its committees which provide a ready forum particularly with regard to the budgetary allocation for energy development and review of the government's policy in this area. Second, the cabinet and its committees — a useful and appropriate forum for collective and consensual planning and decision-making. Third, the PED (Power and Energy Division) of the Planning Commission, the think-tank of the Government of India. The PED, which works on the national energy policy, is concerned with all the plan-related policies and programmes in the energy sector, including demand assessment, supply-side management, and conservation efforts.

A brief description of the regulatory and organizational framework in each of the energy sub-sectors is given below.

Power

'Electricity' is a concurrent subject in the Constitution of India, implying that both the Parliament and the State Legislature have the authority to legislate on the subject. The Indian Electricity Act, 1910 and the Electricity (Supply) Act, 1948 coupled with Amendments in the 1910 Act and 1948 Act; the Indian Electricity Rules, 1956; the Electricity Laws (Amendment) Act, 1998 and the Electricity Regulatory Commission Act, 1998 provide the framework for regulation of electricity in India. There are also state-level legislations in the power sector in several states including Orissa, Andhra Pradesh, Uttar Pradesh, Karnataka, Haryana and Rajasthan.

The MoP (Ministry of Power), Government of India is concerned with perspective planning, policy formulation, processing investment needs of public sector projects, monitoring of the implementation of power projects, training and manpower development. The MoP also undertakes administration and enactment of legislation pertaining to generation, transmission and distribution of thermal and hydropower. It undertakes amendments to these acts from time to time to reflect policy changes.

There are six wings in the Ministry of Power: (1) Transmission and Energy Conservation; (2) Hydel, Reforms and Restructuring; (3) Administration, Co-ordination, Operations Monitoring, Thermal (4) Internal Finance; (5) Investment Promotion Cell, Power Finance Corporation, Power Trading Corporation and Rural Electrification Corporation; and (6) Policy & Planning, External Assistance, Training & Research and Vigilance & Security.

Several organizations in the Indian power sector come under the purview of the MoP, with each of these organizations playing a specific role.

The CEA (Central Electricity Authority) advises the ministry on technical, financial, and economic matters. It also has the statutory function of giving concurrence to schemes involving capital expenditure beyond a certain limit as fixed by the Government from time to time. CEA is also, inter alia, concerned with the development of a sound, adequate, and uniform power policy in relation to the control and utilization of national power resources.

The REC (Rural Electrification Corporation) provides financial assistance for rural electrification programmes.

The NHPC (National Hydroelectric Power Corporation) plans, promotes, and integrates the development of hydroelectric, tidal, and wind power in the country.

The NTPC (National Thermal Power Corporation) is engaged in operating and setting up thermal power projects and gas-based power projects.

The PFC (Power Finance Corporation) is responsible for mobilizing capital from non-budgetary sources for providing term finance for power generation projects.

The PGCIL (Power Grid Corporation of India Limited) is the main provider of extra high-voltage and high-voltage transmission network in the country. It is responsible for all the existing and future transmission projects in the central sector and for the formation of the National Power Grid. It also functions as the CTU (Central Transmission Utility) and is currently concerned with regional grid operations as well.

The Energy Management Centre is an executive agency under the Energy Conservation Cell in the MoP. It formulates policies, designs energy management programmes, and ensures effective coordination. Its main aim is to improve energy efficiency in the country.

Other organizations in the power sector that come under the Ministry of Power include the NEEPCO (North Eastern Electric Power Corporation); the NJPC (Nathpa Jhakri Power Corporation), the THDC (Tehri Hydro

Development Corporation), and two statutory bodies - the DVC (Damodar Valley Corporation) and the BBMB (Bhakra Beas Management Board).

At the state-level, SEBs (State Electricity Boards) constituted by the State Governments, are responsible for ensuring supply, transmission and distribution of electricity in the most economical and efficient manner. For this they are required to co-ordinate with the generating companies, if any, operating in the state and with the central government or any other board or agency that has control over a power system.

The CERC (Central Electricity Regulatory Commission) was set up under the Electricity Regulatory Commission Act, 1998 as an independent statutory body with quasi-judicial powers. The CERC regulates tariff-related matters and inter-state bulk sale of power, aids and advises the central government on the formulation of a tariff policy, frames the guidelines pertaining to tariff, and promotes competition and efficiency in the electricity sector. The Commission also arbitrates or adjudicates in matters relating to tariff.

Several states have set up SERCs (state electricity regulatory commissions) and others are in the process of setting them up (details in the Chapter on Power). The SERCs are engaged in regulating the purchase, distribution, supply and utilization of electricity, the quality of service, the tariff and charges payable considering the interests of both, the consumer, and the electricity industry, in the state. Responsible for promoting competition, efficiency and economy in the activities of the industry, the SERCs also aid and advise in matters concerning generation, transmission, distribution and supply of electricity in the state.

The CPRI (Central Power Research Institute), set up to serve as a national laboratory for undertaking applied research in electric power engineering, also functions as an independent national testing and certification authority for ensuring the reliability of electrical equipment and components.

al

On 1 April 2000, the pricing of coal became fully deregulated with the Colliery Control Order, 2000. This supersedes the Colliery Control Order (1945) of the Essential Commodities Act, 1955 by which the central government had been empowered to fix the prices of coal by grade and colliery.

The MoC (Ministry of Coal) has the overall responsibility of determining policies and strategies relating to exploration and development of coal and lignite reserves and sanctioning of important high-value projects. The MoC operates through several wings, namely, (1) Lignite and Administration; (2)

Coal; (3) Company Affairs (4) Personnel, Reservation, Industrial Relations; (5) Coal Projects, Appraisal and Monitoring; (6) Appointment and Subordinate Organizations and (7) Coal Planning and Foreign Collaboration.

The key functions of the MoC are exercised through CIL (Coal India Limited) and its subsidiaries, and the NLC (Neyveli Lignite Corporation) Limited. Both CIL and NLC are PSUs (public sector undertakings).

The CIL monitors the performance of its eight subsidiary companies and is involved in long-term planning, conservation, R&D in mining. Seven of the CIL's subsidiaries, namely, the ECL (Eastern Coalfields Limited), the BCCL (Bharat Coking Coal Limited), the CCL (Central Coalfields Limited), the NCL (Northern Coalfields Limited), the WCL (Western Coalfields Limited), the SECL (South Eastern Coalfields Limited) and the MCL (Mahanadi Coalfields Limited) are coal producing companies directly engaged in raising and distribution of coal. Another CIL subsidiary, the CMPDIL (Central Mine Planning and Design Institute Limited), is engaged in mine planning and designing in the coal sector and also renders mining and engineering consultancy services.

The NLC is entrusted with the exploration and production of lignite in Tamil Nadu, Rajasthan, Gujarat and Jammu & Kashmir. In Tamilnadu, the NLC is also engaged in the generation of coal-based power.

The MoC also works in close association with the SCCL (Singareni Collieries Company Limited), a coal producing company, which is a joint venture between the Government of Andhra Pradesh and the Government of India.

Petroleum and Natural Gas

The legal framework for the regulation of exploration and production of oil and gas is provided by the Oilfields Development and Regulation Act, 1948 and the Petroleum and Natural Gas Rules, 1959. The Act was amended in 1999 to provide for the NELP (New Exploration Licensing Policy). The downstream sector is regulated mainly by the Indian Petroleum Act and a number of orders passed by the government under the Essential Commodities Act.

The MoPNG (Ministry of Petroleum and Natural Gas) oversees the entire chain of the oil industry : exploration and production of crude oil and natural gas; refining, distribution, and marketing of petroleum products and natural gas, as well as exports and imports of crude oil and petroleum products. The

ministry comprises five wings (1) Administration: (2) Exploration; (3) Refinery; (4) Marketing; and (5) Finance.

Several organizations come under the purview of the MoPNG.

The DGH (Directorate General of Hydrocarbons) was set up in 1993 with the objectives of ensuring correct reservoir management practices, reviewing and monitoring exploratory programmes, development plans for national oil companies and private companies, and monitoring production and optimum utilization of gas fields.

The OCC (Oil Co-ordination Committee) currently performs the function of a planner, co-ordinator, advisor and regulator in the downstream sector.

The ONGCL (Oil and Natural Gas Corporation Limited) and the OIL (Oil India Limited) primarily undertake exploration and production activities in India. The ONGC has also set up a dedicated company ONGC Videsh Limited (OVL) to work on the company's overseas operations.

The Gas Authority of India Limited (GAIL) is responsible for transportation and marketing of natural gas.

Other organizations in the Indian petroleum and natural gas sector include the OISD (Oil Industry Safety Directorate) which develops standards and codes for safety and fire fighting, training programs, information dissemination, etc; the OIDB (Oil Industry Development Board) which provides financial and other assistance for conducive development of the oil industry, the EIL (Engineers India Limited) which provides engineering and consulting services to the petroleum industry, the CHT (Centre for High Technology) which co-ordinates and funds research work in refining and marketing and the PIL (Petroleum India International) which provides technological and managerial expertise to companies abroad.

Additionally, there are a number of organizations in the downstream sector (marketing and refining) sector. These include IOCL (Indian Oil Corporation Limited), the BPCL Bharat petroleum Corporation Limited) and the HPCL (Hindustan Petroleum Corporation Limited) which are integrated refining and marketing companies; the NRL (Numaligarh Refineries Limited), the KRL (Kochi refineries Limited), the CPCL (Chennai Petrochemicals Corporation Limited) and the BRPL (Bongaigaon Refineries & Petrochemicals Corporation) in the public sector; the MRPL (Mangalore Refinery and Petrochemicals Limited) in the joint sector as well as the RPL (Reliance Petrochemicals Limited)

in the private sector, which are stand-alone refining companies; and the IBP (Indo-Burma Petroleum Company Limited) which is engaged only in the marketing of petroleum products. The government is actively pursuing integration of stand-alone marketing and refining companies with IOCL and BPCL.

Renewable Energy Sources & Technologies

The MNES (Ministry of Non-conventional Energy Sources) is responsible for resource assessment, R&D, demonstration, commercialization, and large-scale utilization of NRSE (new and renewable sources of energy) such as biogas, biomass, solar energy, wind energy, small hydro power, improved chulhas, ocean energy, geothermal energy, alternative fuels, hydrogen, and draught animal power. Other important activities of the MNES include awareness creation, information dissemination for the popularization of non-conventional renewable energy devices and systems, and fostering cooperation for financial and technical assistance from multilateral and bilateral agencies.

On the basis of end-use applications of technologies through horizontal integration of various technologies, the MNES has the following sectoral groups: (1) Rural energy; (2) Urban/industrial energy; and (3) Power generation.

The programmes of the MNES are implemented through state nodal agencies, SEBs, R&D institutions, industries, and non-governmental organizations. Since 1996, these programmes have been made more market-oriented, with a greater role for the private sector. IREDA (Indian Renewable Energy Development Agency), set up in 1987, has grown into an effective promotional, developmental, and financing institution and has generated greater awareness of NRSE.

India's renewable energy programme derives strength from technical support provided by the SEC (Solar Energy Centre) and the C-WET (Centre for Wind Energy Technology). The SEC at Gualphari, near Delhi, is involved in testing and standardisation of solar energy devices and systems, R&D work, providing consulting services as well as promoting the use of solar passive architecture - all activities geared towards ensuring enhanced use of solar energy. The role of C-WET at Chennai in Southern India covers a wide range of wind energy-related activities: R&D, technology upgradation, testing certification, standardisation, training and information dissemination.

Additionally, the SNAs (state nodal agencies), also known as energy development agencies are responsible propagating RETs (renewable energy technologies), in tandem with the MNES, in their respective states. These agencies chalk out state level programmes and plans for RETs. The subsidies and other support provided by the MNES, are also channeled through SNAs. In addition to their own schemes, the SNAs also facilitate implementation of various schemes of the MNES.

Atomic Energy

The overall development, control and use of atomic energy in India is guided by the Atomic Energy Act, 1962, which seeks to ensure that atomic energy activities are carried out keeping in mind the welfare of the people of India and for peaceful purposes. Other legislation on atomic energy relates to several issues including control of irradiation of food, radiation protection, and safe disposal of radioactive wastes.

The AEC (Atomic Energy Commission) set up in 1948, controls all activities towards ensuring peaceful exploitation of nuclear energy. The AEC formulates policies for the DAE (Department of Atomic Energy), prepares its budgets and ensures that policies are implemented. The Atomic Energy Regulatory Board, under the AEC is responsible for regulatory and safety functions.

The DAE set up in 1954 is responsible for R&D, uranium exploration and production, fuel element design, as well as construction and operation of heavy water plants.

The NPCIL (Nuclear Power Corporation of India Limited) is a wholly owned Undertaking of the Government of India under the administrative control of the DAE. The NPCIL undertakes the design, construction, operation, and maintenance of the atomic power stations for generation of electricity.

Atomic research centres in India include the Bhabha Atomic Research Centre; the Centre for Advanced Technology; the Indira Gandhi Centre for Atomic Research, and the Variable Energy Cyclotron Centre.

2 Coal

Reserves & production

The Geological Survey of India has estimated India's proven coal reserves at 82396 MT (million tonnes), which is approximately seven per cent of the total world reserves as on 1 January 2000 (Table 1.01). The total coal reserves are estimated at 211 593.6 MTa of which nearly 86% are non-coking coal reserves (Table 1.02).

Lignite reserves in the country have been estimated at around 30322 MT. Of this 26 753 MT is in Tamil Nadu and Pondicherry, the rest in Gujarat and Rajasthan with small quantities in Kerala and Jammu and Kashmir (Table 1.03).

India is the third largest coal producer in the world. The CIL (Coal India Limited) and its subsidiaries are the major producers of coal, contributing approximately 86% of the coal produced in India. Through a sustained programme of investment and greater thrust on application of moder technologies, it has been possible to raise the production of coal to 300 MT in 1999/2000 as compared to 100 MT in 1975/76. (Table 1.04).

With the rising energy demands and the concerns for energy security in the rapidly changing environment of the coal industry, it is important to address the various issues regarding the exploitation of the country's coal resources. Some of the important issues in this regard are with regard to the exploitation technologies and quality of coal mined, adequacy of environmental and resource utilization policies and the legislative setup for the sector.

Location & quality of resources

Coal reserves in India are spread out in the major coalfields of the country in the states of Bihar, W.Bengal, Assam, Madhya Pradesh, Orissa, Maharashtra, Andhra Pradesh and some parts of Uttar Pradesh.

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[a] Annual Report 1999-2000, Government of India, Ministry of Mines & Minerals, Department of Coal

Although the reserves are substantial, Indian coal is generally of low quality with high ash content and low calorific value. Indian coal predominantly exists in thick seams (approximately 70% of coal reserves are locked up in seams over 3.5 m thick and of this, 58% is in seams over 5 m thick) interbanded with extraneous matter. Additionally, the coal seams in India are also complex with a multiplicity of coal horizons (20-25 in Jharia, 30-36 in Karanpura & 10 in Raniganj).

In addition, some of the major consumption sites are located unfavourably in relation to the reserves placing an enormous burden on the transport infrastructure.

The best quality of metallurgical coal is found only in the mines of Jharia (Bihar) and in some mines in Raniganj (W.Bengal). The mining of these good quality coals is complicated because of the large-scale indiscriminate exploitation in this area in the pre-nationalization era and the heavy built-up areas over such deposits. Also, millions of tons of good quality coal has been left in pillars and Jharia and Raniganj mines also have large areas under fire. As a result, the production of coal from these areas has been declining over the past few years.

The potential areas and new finds identified during the Eighth Plan period with good quarriable prospects are located in East Bokaro, South Karanpura and Sohagpur coalfields for metallurgical coal; Birbhum, Sohagpur, Mand-Raigarh, Tatapani-Ramkola and Korba for superior grade non-coking coal and Talcher, Korba, Rajmahal and Auranga coalfield for inferior grade non-coking coal.

The quality of power grade coal has been deteriorating over the years. The power plants largely receive E, F and G grade coals with large amounts of ash and shale. As per the notification of 19th September 1997, power plants located in urban centres, sensitive areas, critically polluted area and which are more than 1000 kms from the source of supply are not allowed to use coal with ash content greater than 34%. While this order has become applicable for the first three categories of power stations, the fourth one gets implemented from 1st June 2001. This notification has left some consumers with no option but to resort to coal imports, since adequate quantity of the requisite quality of coal could not be provided domestically.

With regard to the issue of beneficiation of coal, washing of Indian coal is difficult due to the presence of near gravity impurities, making it difficult to

separate the ash and coal. It was envisaged that the existing washeries would undertake necessary modifications and retrofitting in order to maintain the average ash content in the washed coking coal for steel plants at the desired level of 17% (+/- 0.5%) as per the Altekar Committee recommendations. However, the problem of higher ash content has remained as a result of which the steel industry has been resorting to an increased dependence on imports.

Blending of imported and domestic coal emerges as a possible option to improve the quality. However, the infrastructure requirements for blending coal may also be a constraint with the existing consumers. Improvement in quality by selective mining using surface miners has shown great potential in certain mines. This is being used only in a couple on mines and needs large scale implementation to be effective.

Mining technology

In India, mining technology has shifted rapidly in favor of opencast mining over the last decade. Although there has been an overall increase in overall coal production, it has mainly been due to increased production from opencast mines. Of the total projected production for the Ninth Plan, 75% was envisaged to come from opencast mines and 25% from underground mines.

In spite of substantial investment in the co[illegible] underground mining has made little progress in terms of productivity due to difficult mining conditions, low levels of skill, and a large workforce.

This trend is fast depleting the reserves amenable for opencast mining and neglecting the development of underground mines where large potential exists for meeting the future demand. Immediate action, therefore, need to be initiated for developing underground mines in view of their long gestation periods.

The quality of coal has also been deteriorating with a larger share of opencast mining, since this technology results in the mixing of overburden and extraneous matter with the coal in the process of extraction. Recently, the use of surface miners in some mines of Ib valley coalfield has been able to extract coal with a minimum level of extraneous matter. The surface miners extract slices of coal in layers of about 15 cms to 23 cms thickness, thereby being able to segregate layers that do not contain shale.

There has been an improvement in the productivity or overall OMS (output per man-shift) during the last decade for CIL and the SCCL (Singareni Collieries

Company Limited) group of companies. The overall productivity is 2.0 for the CIL and 1.3 for the SCCL. While the OMS for opencast mining has improved, the OMS for underground mining has either declined or stagnated (Table 12). Comparative performances of other countries include an average of 37.5 tonnes per man-shift in the US in 1994 and 43 tonnes per man-shift in Germany's Hambach lignite mine. There is a large scope for productivity improvements in Indian mines.

Demand estimates & production targets

The Planning Commission had assessed the demand for coal at 412 mt in 2001-02, 545 mt in 2006-07 and 775 in 2011/12 (corresponding to the low hydro-generation and high liquid fuel based generation of power) while formulating the 9th Five Year Plan[a]. The corresponding production levels were estimated at 370.6 mt, 499 mt and 672 mt for the respective years. This demand was reassessed at 370.80 million tonnes (excluding 7.70 million tonnes of middlings) for 2001-02 during the mid term reassessment of the Plan. The overall indigenous coal production was also revised to 359.60 mt for 2001-02. The target and actual production for each year of the 9th Plan is given in Box 1.

Box 1. Annual demand as assessed by the Planning Commission for the 9[th] Plan

Year	Demand (million tonnes)
1997-98	323.40 (6.80)
1998-99	325.38 (7.50)
1999-00	311.83 (3.00)
2000-01	333.85 (5.02)
2001-02	370.80 (7.70) provisional

*Figures in () are for middlings

Source. Annual Report 1999-2000, Government of India, Ministry of Mines & Minerals. Department of coal

When compared with the domestic availability, the projected demands for coal reveal a large demand-supply mismatch. Unless domestic production is augmented, the country would need to import a large quantity of coal (both coking as well as non-coking) and this would imply a drain on our foreign exchange. The investment requirements for meeting the Ninth Plan requirements alone for increasing domestic production are estimated to be over Rs 20,000 crores.

[a] Planning Commission, 9th Five Year Plan, Volume I

Sector-wise coal supply

Table 1.19 provides the annual availability and estimated sectorwise consumption of raw coal over the past few years. As seen from the table, the coal consumption levels for steel and cement have remained more or less static, while the demand for coal in the electricity generation sector has increased rapidly. Tables 1.20A & 1.20B provide the supply of coal to steel plants over the past 4 years. The data clearly indicates a decreasing supply of prime, medium and blendable coking coal to the steel plants over the years under consideration. This is largely attributable to the increasing inadequacy in indigenous supplies of good quality coking coal.

Movement of coal

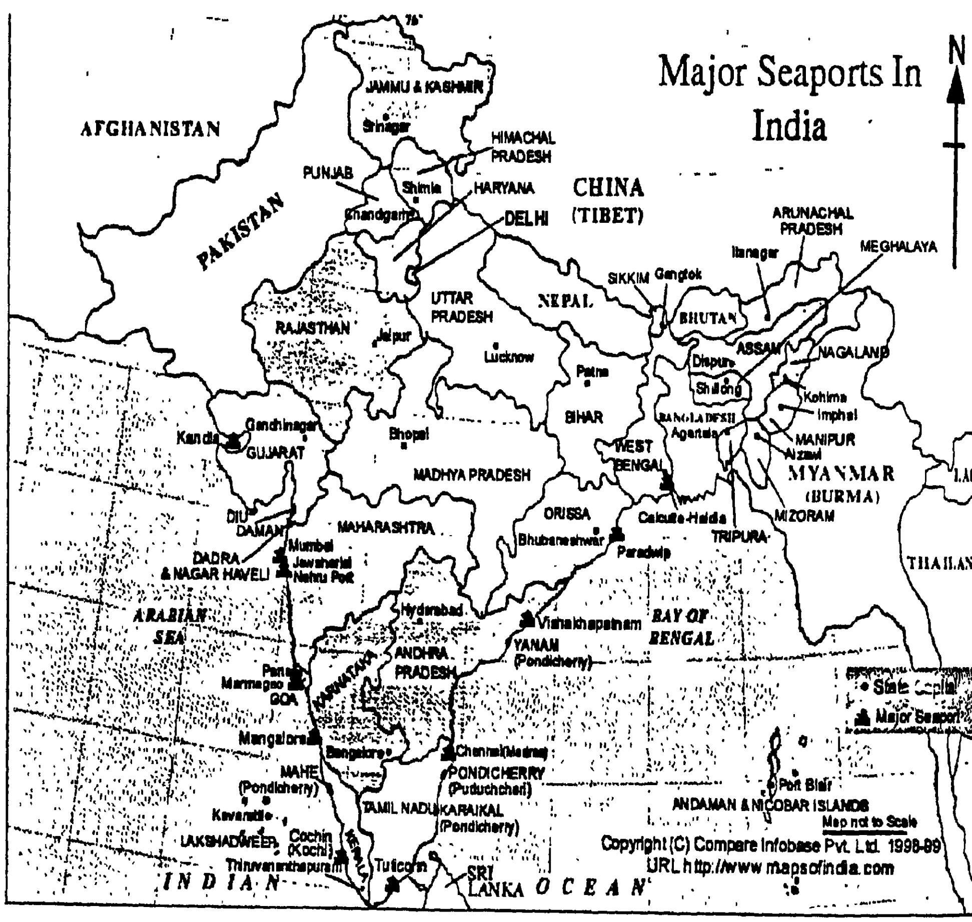
Since most of the coal production is restricted to the Eastern and South-Eastern belt of the country and core consumers such as power and steel plants are often distant from the coalfields, transportation of coal to the consumers is a major consideration in India. The railways are the main mode of transportation followed by captive systems such as merry-go-rounds (MGR). Road transport, conveyors, and aerial ropeways are also used. Sea-borne movements account for about six per cent of India's domestic coal transport. Coastal shipment is used for supplying coal to consumers in southern India. Table 1.21 provides the inter-modal split of coal movement in the country.

The freight of coal on the Indian railways is among the highest in the world. This is because the freight of some essential commodities like food grains and fertiliser and the passenger fare has been has been kept very low. This cross subsidisation is resulting in very high transportation cost and resulting in loss of market for Indian coal. The freight rates for coal movement by rail can be obtained from TERI (to be discussed).

India has 11 major ports that are administered by the port trusts under the control of the Central Government and are governed by the major Port Trusts Act, 1963, the Indian Ports Act, 1908 and the rules and regulations formed thereunder. Map 1 shows the major ports in India. Haldia, Paradip, and Vishakhapatnam are the most important ports on India's eastern coast and handle movement of thermal coal destined to Chennai and Tuticorin. These ports, especially Vishakhapatnam, also handle large imports of coking coal and some quantity of "other" coal. However, of these, only Haldia and Tuticorin have dedicated coal berths. Paradip, Vishakhapatnam and Chennai presently handle coal at non-coal or multi-purpose berths. Table 1.22 provides the capacity and traffic handled at the major ports.

Additionally, there are 179 intermediate/ minor ports situated along the 5560 kms of coastline of the country. The responsibility of minor ports lies with the concerned maritime state government. The list of minor ports is attached as Annexure 1. Recently, a few minor ports have also started handling coal imports. Although some of these ports do not have adequate coal handling capacity and proper jetties, coal has been unloaded from the ships berthed at the high seas by using small barges. This is indicative of the rising demand for imported coal as well as the need for infrastructural development of the ports. Recently, the government has allowed private sector participation in the development and augmentation of port facilities.

Map 1: Major Seaports in India



LIST OF MAJOR PORTS

- Calcutta & Haldia
- Paradip
- Vishakhapatnam
- Chennai
- Tuticorin
- Cochin
- New Mangalore
- Mormugao
- Mumbai
- Kandla
- J.L.Nehru

Annexure 1

List of Minor Ports :Source- Basic Ports statistics of India 98-99

GUJARAT

Mandvi (I)
Navlakhi
Bedi (I)
Sikka (I)
Jafarabad
Okha (I)
Porbandar (I)
Veraval (I)
Bhavnagarg (I)
Bharuch
Magdalla (I)
Koteshwar
Mundra
Jakhau
Jodia
Salaya
Pindhara
Beyt
Rupen
Mangrol
Kotda
Madhwad
Navabandar
Rajpara
Pipavav/Victor (I)
Mahuva
Talaja
Ghogha
Khambhat
Dahej
Bhagwa
Onjal
Vansi- Borsi
Billimora
Valsad
Umarsadi
Kolak
Maroli
Umergaon
Mul- Dwarka
Panvel
Mora
Mandwa
Karanja
Thal

KARNATAKA

Mangalore (I)
Malpe
Hangarkatta
Kundapur (I)
Bhatkal
Honavar
Tadri
Beleken
Karwar (I)

ORISSA

Gopalpur
Behrabalpur (N)
(Balasore)

ANDHRA PRADESH

Bhavanapadu (N)
Callingapatnam (N)
Kakinada (I)
Narsapur (N)
Machilipatnam (N) (I)
Vadarevu(N)
Nizampatnam (N)
Krishnapatnam (N)
Gangavaram (N)
Mutyalampalem (N)
Rawa

LAKSHADWEEP

Agatti
Amini
Androt
Bitra
Chetlat
Kavaratti
Kadmat
Kiltan
kalpeni
Minicoy

ANDAMAN NICOBAR

Port Blair
Mus
Car Nicobar
Havelock

GOA

Panaji
Chapora
Betul
Talpona
Tiracol

TAMILNADU

Cuddalore (I)
Nagapattinam (I)
Rameswaram
Pamban
Colachel
Valinokkam
Kanyakumari
Ennore (C)
Punnakkayal (C)
Thirukkadaiyur (C)
PY-3 (oil field) (C)
Kattupalli (C)
Thiruchapuram (C)
Manappad (C)

MAHARASHTRA

Dahanu
Tarapur
Nawapur
Satpati
Kelwa-Mahim
Amala
Datiware
Uttan
Bassein
Bhiwandi
Manori
Kalyan
Thane
Versova
Bandra
Trombay
Ulwa-Belapur
Thalassery (N)
Thiruvananthapuram (N)
Quilon (N)
Kozhikode/Beypore (I)
Neendakara (I)

Rewa
Alibag
Dharamtar
1Revdanda
Borli/Mandla
Nandgaon
Murud-Junjira
Rajpuri
Mandad
Kumbharu
Shriwardhan
Bankot
Kelshi
Harnai
Dabhol
Palshet
Borya
Jaigad
Tiwri-Waroda
Purnagad
Jaitapor
Vijaydurg
Deogad
Achara
Malvan
Niwti
Vengurla
Redi
Kiranpani
Ratnagiri
Dighi

Mayabunder
Diglipur
Rangat
Hut Bay
Katchal
Campbell Bay
Neil Haveloc
Dugong Creek
Nancowry
Chowra
Teressa
Kondul
Pillow Millow
East Island
Cinque Island
Jolly Buoy Island
Tillangchong
Castla Bay
South Bay

DAMAN & DIU
Daman (N)
Diu (N)

KERALA
Alppuzha (N)
Vadakara (N)
Kannur (N)
Kasargode (N)
Kodungallore (N)
Ponnani (N)
Azhikkal
Koavalam/Vizhinjam

PONDICHERRY
Pondicherry

3 Oil and gas

Organisation of the hydrocarbon sector in India

The Ministry of Petroleum and Natural Gas (MoP&NG) oversees the entire chain of the oil industry: exploration and production of crude oil and natural gas; refining, distribution, and marketing of petroleum products and natural gas as well as exports and imports of crude oil and petroleum products.

Oil and Natural Gas Corporation Ltd (ONGCL) and Oil India Ltd (OIL) primarily undertake exploration and production activities in India. ONGCL has also set up a dedicated company ONGC Videsh Ltd (OVL) to cater to the company's overseas operations.

While Numaligarh Refineries Ltd (NRL), Kochi Refineries Ltd (KRL), Chennai Petrochemicals Corporation Ltd (CPCL) and Bongaigaon Refineries and Petrochemicals Corporation (BRPL) are stand alone refining companies, Indian Oil Corporation Ltd (IOCL), Bharat Petroleum Corporation Ltd (BPCL) and Hindustan Petroleum Corporation Ltd (HPCL) are integrated refining and marketing companies. IOCL commands the lion's share of the downstream petroleum industry. The IBP Company Ltd is engaged in marketing of petroleum products only. The government is actively pursuing integration of stand-alone marketing and refining companies with IOCL and BPCL. The Gas Authority of India Ltd (GAIL) is responsible for transportation and marketing of natural gas.

Other organisations under the Ministry's purview include:

- Engineers India Ltd: Engineering and Consultancy services to the petroleum industry
- Lubrizol India Ltd: Manufacturing of additives for automotive and industrial lubricants
- Indian Additives Ltd: Manufacturing of additives and blending
- Balmer Lawrie & Co Ltd: Manufacturing of lubricants and greases, performance chemicals, engineering and consultancy, etc
- Bieco Lawrie Ltd: Engineering services, turnkey projects, etc
- Oil Industry Safety Directorate: Develops standards and codes for safety and fire fighting, training programs, information dissemination, etc

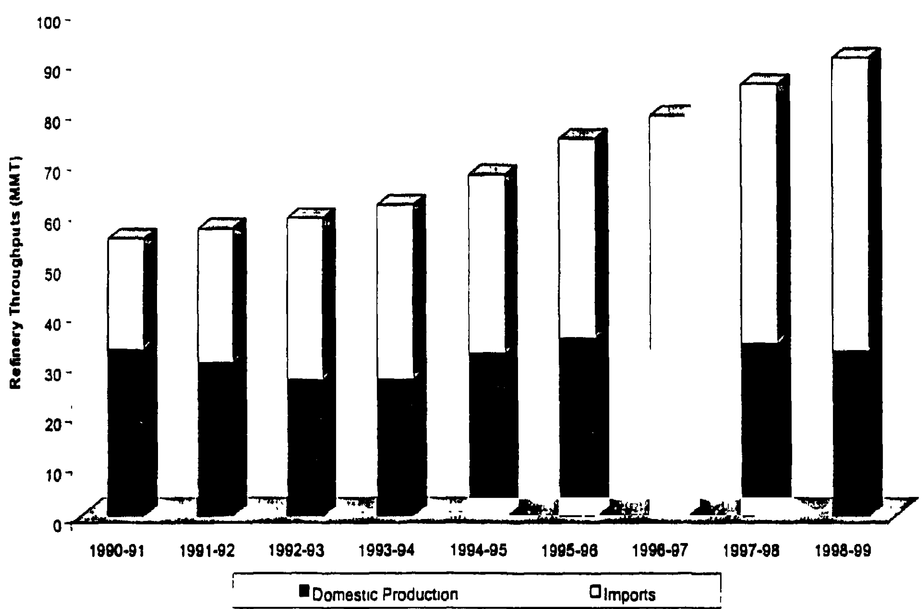
- Centre for High technology: Co-ordinating and funding research work in refining and marketing
- Petroleum India International: Provides technological and managerial expertise to companies abroad
- Oil Co-ordination Committee: Responsible for a plethora of activities including monitoring, planning, distribution, pricing, imports/exports, etc
- Oil Industry Development Board: Provides financial and other assistance for conducive development of the oil industry
- Directorate General Hydrocarbons: Management of petroleum and gas resources

Exploration and production

India's 26 sedimentary basins account for 1.35 million sq. km of onshore area and 0.39 million sq. km of off-shore area (upto 200 m isobath water depth). The country has a total prognosticated resource base of 21 billion tonnes with an additional 9 billion tonnes from deep-water areas. Out of this only 6.8 billion tonnes of geological reserves have been established through exploration, leaving 2/3 of the area unexplored. Balance recoverable reserves as on 1.4.99 stood at 1.4 billion tonnes of oil and oil equivalent gas.

Over the years, domestic availability of crude has not kept pace with consumption. Self reliance has dropped from 56% in 1990/91 to 34% in 1998/99. Figure 1 presents a snapshot of this growing imbalance.

Figure 1. Trends in crude availability (Million Tonnes)



Source. Ministry of Petroleum & Natural Gas (MoPNG)

The exploration and production of oil and gas has been primarily in the hands of two national oil companies: Oil and Natural Gas Corporation Ltd (ONGCL) and Oil India Ltd (OIL). However, as indicated above, over the recent years domestic production has been accounting for a progressively smaller portion of the refinery throughputs. The high import dependence for crude constitutes a major drain on the country's foreign exchange reserves. An urgent need to increase domestic crude availability through increased exploration in the country was thus felt. However, such an exercise would require massive financial investments. The Ministry of Petroleum and Natural Gas has estimated that investments for the development of indigenous oil and gas would be of the order of $ 60 billion in the next 15 years. Such large-scale investments are beyond the scope of national oil companies and, thus, the involvement of the private sector becomes imperative.

New Exploration Licensing Policy

Since 1991, the government has been inviting bids from private sector on a regular basis. Altogether 35 exploration blocks and 30 discovered fields have been awarded to the private sector. The total investment by the private sector in these is estimated to be in excess of $ 2 billion. In 1998/99, private and JV

companies accounted for about 10% of the total domestic production of oil and gas. Trends in production of oil and gas by the private sector are summarised in Table 1.

Table 1. Oil and gas production by NOCs and private & joint venture companies

Year	*Oil (MMT)*			*Gas (BCM)*		
	NOCs	*Pvt/JV*	*Total*	*NOCs*	*Pvt/JV*	*Total*
1995/96	34.5	0.7	35.2	22.3	0.3	22.6
1996/97	31.6	1.3	32.9	22.7	0.5	23.3
1997/98	31.3	2.5	33.9	24.7	1.7	26.4
1998/99	29.7	3.0	32.7	24.6	2.9	27.4

Source. Basic Statistics on Indian Petroleum and Natural Gas: 1999, MoPNG

In order to boost domestic oil and gas production, the government also announced the New Exploration and Licensing Policy (NELP). Positive features of the NELP include,

- No mandatory state participation
- Competitive bidding of blocks by NOCs as against nomination basis
- Carried interests of NOC abolished
- Exemption from payment of cess
- Incentives for deep-water exploration
- Seven year tax holiday from date of commercial production

Altogether, a total of 48 blocks (10 onshore, 26 shallow water offshore and 12 deepwater offshore blocks) were put on the offer. As a result, 45 bids for 27 Blocks (4 onshore, 16 shallow water offshore and 7 deep water offshore) were received. 25 blocks were approved for award by the Petroleum Ministry. These include 2 onland blocks, 7 deepwater blocks and 16 shallow water off-shore blocks. Deep water blocks beyond the 400-m isobath were offered for the first time in India. The names of the awardees are indicated in Table 2.

Table 2. Awardees under the NELP

Name of awardee	*Blocks awarded*
Oil & Natural Gas Corporation Ltd. (ONGC)	KG-DWN-98/4 (Krishna-Godawari Deep Water offshore), KG-DWN-
ONGC-Indian Oil Corporation Ltd. (IOC)	GV-ONN-97/1 (Ganga Valley onshore) & MB-OSN-97/4 (Mumbai
ONGC-Gas Authority of India Ltd. (GAIL)	MN-OSN-97/3 (Mahanadi Shallow Water offshore)
Oil India Ltd. (OIL)	CY-OSN-97/2 (Cauvery Shallow Water offshore)
GAIL-Gazprom	NEC-OSN-97/1 (North East Coast Shallow Water offshore)
Cairn Energy India Pvt. Ltd.	KG-DWN-98/2 (Krishna-Godawari Deep Water offshore)
Reliance Industries Ltd. (RIL)-	KG-DWN-98/1 (Krishna-Godawari Deep Water offshore), KG-DWN-
Mosbacher - Energy Equity -	CY-OSN-97/1 (Cauvery Shallow Water offshore)
Geoenpro Petrol Ltd.- Geopetrol International -	ARP-ONN-97/1 (Arunachal Pradesh onshore)

Source. Directorate General Hydrocarbons

The government signed PSCs (production sharing contracts) for 25 oil blocks in April 2000. These included PSCs for three other oil blocks, for which bidding had taken place a few years ago, but PSCs could not be signed for various reasons. RIL, in collaboration with its partners, signed PSCs with the government for 13 blocks, while national oil companies and one overseas oil company signed PSCs for 12 oil blocks.

These consortia have agreed to invest about $1.8 billion in three phases. Of this, about $232.5 million is to be spent by these contract awardees during the first phase of the next four years. The Ministry of Petroleum and Natural Gas has announced the second round of the NELP to be held in October 2000. 23 prospective blocks are expected to be put on offer, which would include deep-water blocks along the west coast. The blocks will be offered as per terms and conditions of the NELP with only administrative changes.

Refining

The present refining capacity of the 17 Indian refineries adds up to 112.04 MMTPA. However, since the refineries at Jamnagar and Numaligarh were commissioned during 1999/00, the combined throughput in the same year was much lower at 86 million tonnes of crude. With the exception of the Mangalore refinery (joint sector) and the Jamnagar refinery (private sector), all other refineries are public sector units.

Four new refineries are expected to be commissioned by the end of the Tenth Plan. These include the private sector refineries at Vadinar (Essar) and Cuddalore (Pennar); IOC's refinery at Paradeep; and HPCL's refinery at Bhatinda. Altogether, with the expansion of existing refineries and the commissioning of new ones, the refining capacity in the country is expected to increase to 178.59 MMTPA by 2006/07.

Demand and supply

Sales of petroleum products in 1998/99 aggregated 89.4 MMT, of which imports by private parties accounted for 5.8 MMT. As against this, domestic production of petroleum products aggregated only 64.5 MMT. In addition, another 3.6 MMT of products were extracted from natural gas in the form of LPG and natural gas liquids (NGL). Middle distillates constituted bulk of the product imports of 18.8 MMT, of which high speed diesel (HSD) imports added up to 10.5 MMT and superior kerosene oil (SKO) imports aggregated 5.8 MMT.

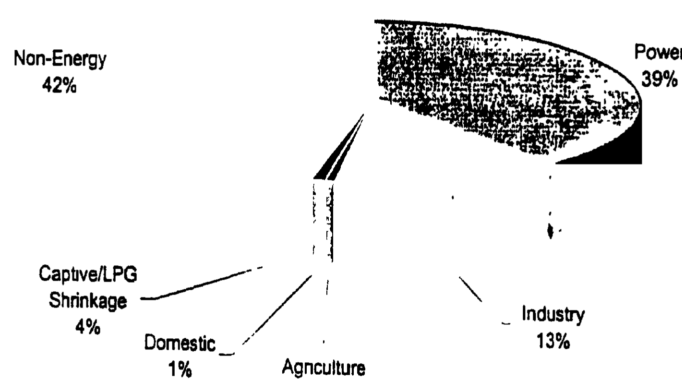
The situation is likely to be quite different for the year 2000/01 on account of the recent additions to refining capacity in the country. Reportedly, no HSD imports are envisaged for the current fiscal. In addition, motor spirit (MS) surplus is expected to be about 3.6 MMT while that for naphtha around 1 MMT.

Natural gas

Demand and supply

The demand for natural gas in the country has been growing rapidly. Gas sales in the country increased at an annual rate of 7.4% during the period 1990/91-1998/99. The demand for gas accrues from preference of gas use in power generation and fertiliser production. Gas sales in 1998/99 aggregated 22.5 billion cubic meters(BCM). The sectoral shares are presented in Figure 1.

Figure 1 Industry wise off-take of natural gas: 1998/99



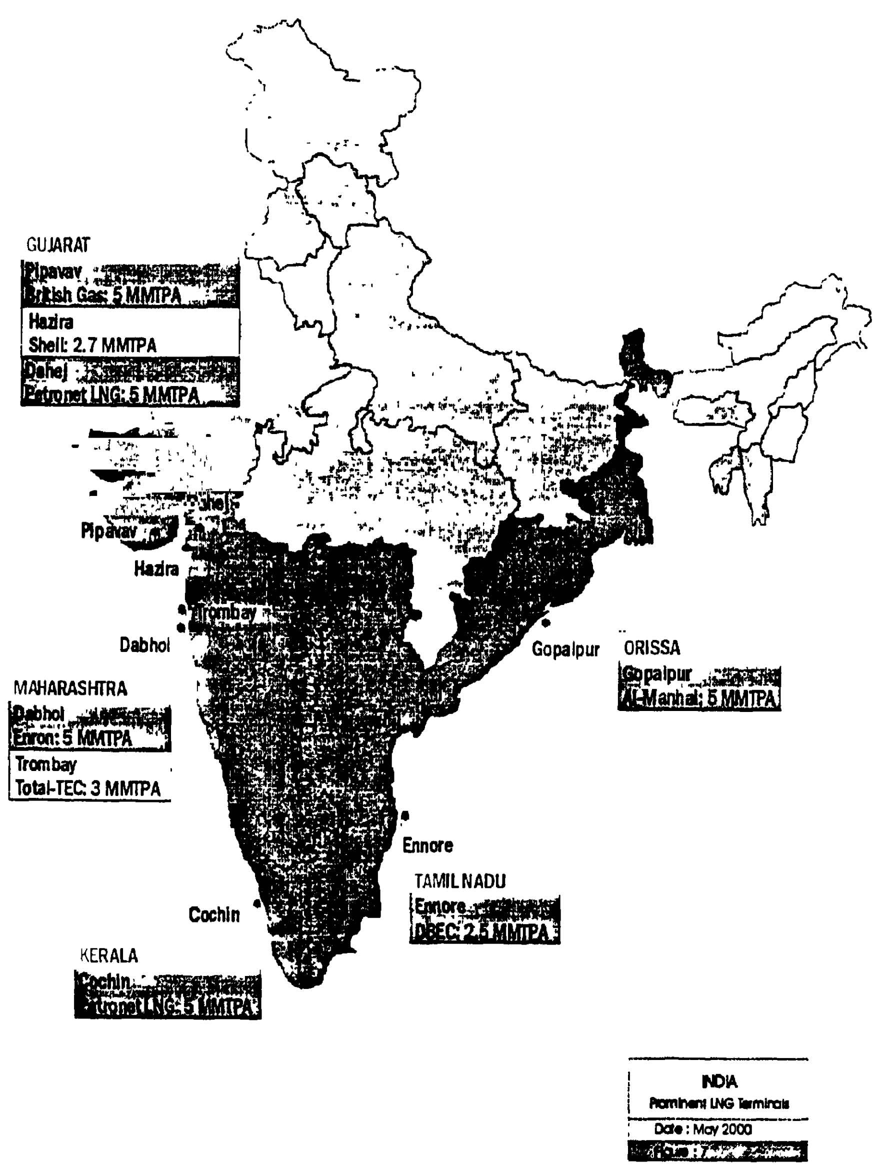
The power and fertilizer sectors together consume about 80% of the gas today. The sponge iron units consume another 10%. The balance goes to industrial units where it replaces mostly fuel and LPGas well. Gas is also supplied to the residential and the commercial sectors in Mumbai, Delhi and a few towns of Gujarat, Assam and Tripura.

Gas production in the country stood at 27.4 BCM in 1998/99. As per the projections of the Sub-Group on Utilisation of Natural Gas constituted under the Hydrocarbon Vision 2025, domestic gas availability is expected to be about 16

BCM by 2011/12. In light of this, the rising gas demand in the country would have to be met from imported gas. However, given the fact that most of the proposals for importing gas by pipeline are not likely to fructify in the near future, immediate imports are likely to be in the form of liquefied natural gas (LNG).

Liquefied Natural Gas (LNG)

On account of the anticipated deficits in domestic gas availability, a number of LNG projects have been proposed in the country (Figure 2). A brief description of a few of the prominent ones is presented below.



US based Enron was the first company in India to come up with a proposal for setting up a LNG terminal. The LNG project was envisaged under the 2450 MW Dabhol Power Project. Phase I (826 MW) of the project has commenced operations on liquid fuel and the company has achieved financial closure for Phase II (1624 MW), which includes the 5 MMTPA LNG terminal. The terminal is expected to be commissioned by November 2001. Part of the gas from the proposed terminal (2.6 MMTPA) would be taken by the Metropolitan Gas Company, a 100% subsidiary of Enron India.

Tata Electricity Company (TEC) and Total Gas & Power India (TGPI) are setting up a 3 MMTPA LNG terminal at Trombay, Maharshtra. TEC's thermal plants at Trombay are expected to switch over to LNG by 2003 to coincide with Phase I of the project for 1.3 MMTPA of LNG. The two companies have also formed a JV with GAIL, Indian Natural Gas Co (INDIGAS), for marketing the gas during Phase II.

Petronet-LNG, promoted by GAIL, ONGC, IOC, BPCL and NTPC, is putting up a 5 MMTPA LNG terminal at Dahej, Gujarat and 2.5 MMTPA terminal at Kochi, Kerala. The company has signed an agreement with Qatar's Rasgas for supply of 5 MMTPA of LNG from mid-2003 and 2.5 MMTPA by 2005.

Dakshin Bharat Energy Consortium, a JV of Unocal, Siemens, Grasim, CMS, and Woodside, has proposed a 2.5 MMTPA LNG terminal at Ennore, Tamil Nadu. The proposal, to be developed in collaboration with Tamil Nadu Industrial Development Corporation (TIDCO), includes a 1850 MW power plant.

British Gas and Sea King Infrastructure are putting up a 5 MMTPA LNG terminal at Pipavav, Gujarat. NTPC is ready to sign an agreement to form a joint venture company - Gujarat Pipavav LNG Ltd. NTPC is expected to pick up 26% stake in the project, while British Gas and Sea King Infrastructure would each hold 25% stake. The project, is expected to be commissioned by 2003. LNG from the proposed terminal will be used at the NTPC's Kawas and Gandhar power projects. NTPC's total requirement for these projects is expected to be about 1.5 MMTPA.

In January 2000, the Orissa government signed an agreement with Al-Manhal International Group to set up a LNG complex consisting of an LNG re-gassification terminal of 5 MTPA, a petrochemical complex, a urea-ammonia fertiliser complex of 1.2 MMTPA capacity and a 2500-3000 MW power plant. The Gopalpur LNG project will source gas from ALNG (Australia Liquefied Natural Gas). ALNG has committed to supply 5 MT of liquefied gas annually for 20 years.

Other companies with proposals for LNG terminals in the country include Shell (Hazira) and RIL (Sikka). These are, however, at relatively nascent stages of development as compared to the ones listed above.

Transport Infrastructure

The existing gas infrastructure supports production and transportation of about 90 million standard cubic metres per day (MMSCMD) of gas and transmission and distribution of about 65–70 MMSCMD. The western offshore region is the major source of gas, accounting for more than 70% of the total gas production. Adequate offshore facilities exist for the compression and evacuation of gas to shore-based facilities at Uran in Maharashtra and Hazira in Gujarat. The shore-based facilities in Uran receive gas from two offshore trunk gas pipelines, namely, Bombay High to Uran and Heera Field to Uran. Similarly, the shore-based facilities at Hazira receive gas from two offshore gas trunk pipelines from the South Bassein field.

The Bombay High–Uran pipeline has a diameter of 65 cm and a capacity of about 13 MMSCMD. The two gas pipelines from South Bassein to Hazira are 90 cm and 105 cm in diameter with capacities of 22 and 30 MMSCMD, respectively. While the terminal at Uran can handle 16 MMSCMD of gas, the terminal at Hazira is being expanded to handle 41 MMSCMD. The Hazira terminal has gas sweetening facilities for treatment of sour gas from South Bassein and other offshore fields.

As far as the gas transmission and distribution network is concerned, a system of about 3800-km long pipeline trunk as well as spur (consumer) lines is presently in position. The largest pipeline system is the HBJ (Hazira–Bijapur–Jagdishpur) trunk pipeline system, which is more than 2000 km in length (Figure3). The capacity of the HBJ system has been expanded from 18.3 MCM a day to 33.4 MCM a day in July 1998 at a cost of 23.76 billion rupees. As part of the expansion plan, a trunk section (90 cm in diameter) has been added between Bijapur and Dadri. In addition, there are regional gas grids of varying sizes in Gujarat (Cambay Basin), Andhra Pradesh (Krishna–Godavari Basin), Assam (Assam–Arakan Basin), Maharashtra (Ex-Uran terminal), Rajasthan (Jaisalmer Basin), Tamil Nadu (Cauvery Basin), and Tripura (Arakan Basin).

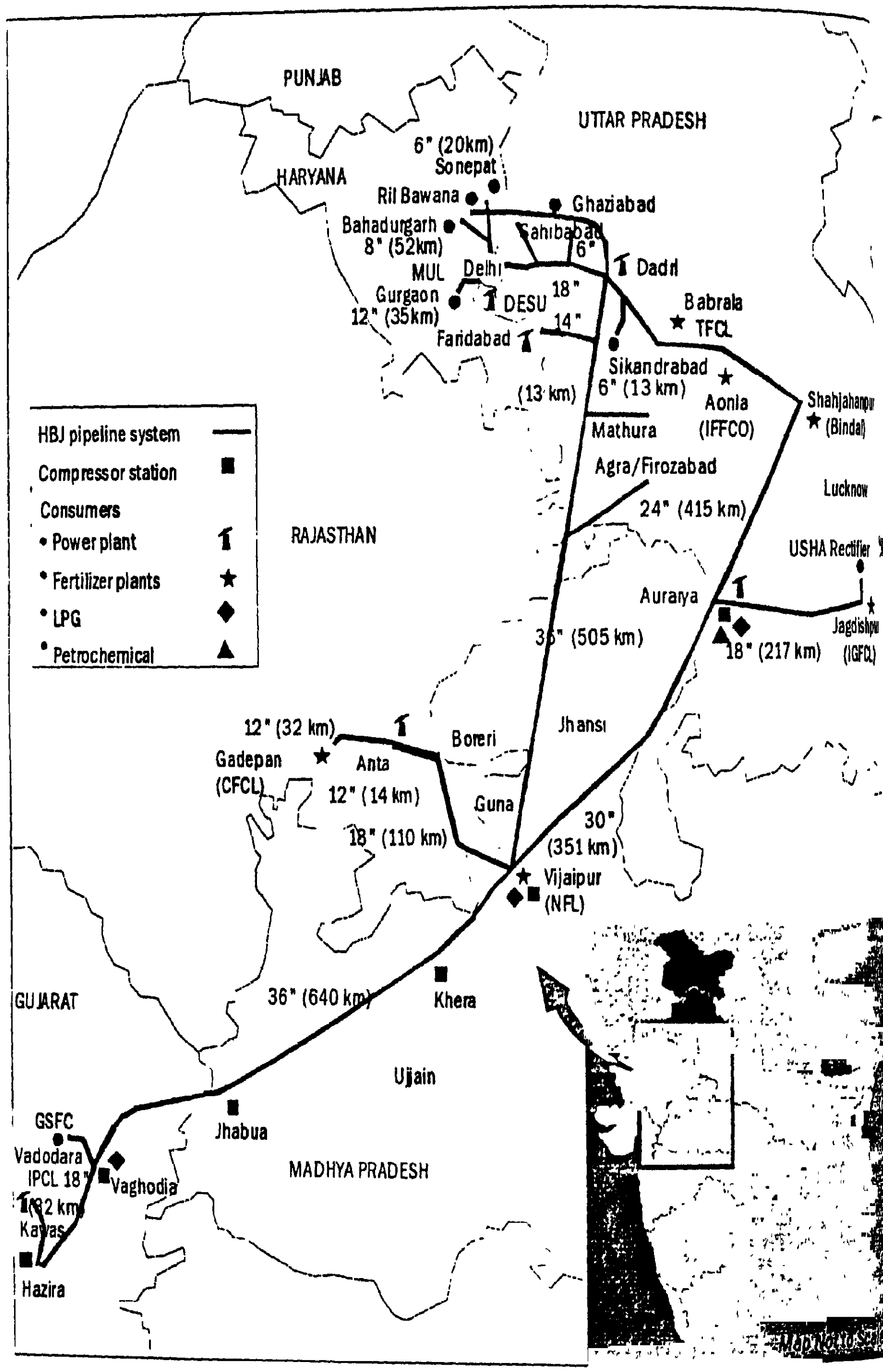
To facilitate carrying LNG from the Dahej terminal, GAIL is planning to upgrade its systems to enhance the capacity of the HBJ pipeline from 34 MMSCMD to 60 MSCMD. GAIL is also planning to add new pipelines in the

Krishna Godavari and Cauvery basins. A pipeline from Hazira to Uran is also envisaged.

The future requirement of major gas sector infrastructure as well as other facilities would depend upon the mix of modes of gas imports i.e., LNG and pipeline gas.. The investments required on gas infrastructure development would considerably higher in case of LNG import projects, due to the need to set up expensive terminals. Typically, a LNG import terminal of 3 million tonnes per annum capacity would require an investment of the order of US$400 to 500 million depending upon the site characteristics. However, the expansion of such terminals can be undertaken by relatively lesser investment. For example, spending 30% to 40% of the initial capital cost can double the capacity of the terminal. If one considers that most of the future gas requirements would come from import of LNG, about 6 to 7 LNG terminals can be considered operational between now and 2025. These terminals, at present date costing, would need an investment of about US$3.5 billion.

The HBJ pipeline system would be further expanded, to more than double its existing capacity, for marketing of LNG/gas imported in the Western region and this would require an investment of about US$1.5 billion. There would be number of other pipelines related investments required for supporting regional pipeline systems as well as pipelines from the proposed LNG terminals. This may require an investment of another US$2 billion. If it is considered that during the same period the pipeline gas from Bangladesh and Iran also fructifies, the investment within India for marketing such gas from the land fall point could involve an investment of US $ 2 billion. Linking these major cross country infrastructure would be further regional spur lines and networks for expanding coverage of gas market which too need very sizable investments. Thus in the next 20 to 25 years time the gas sector may need an investment of US $ 10 billion on setting up of LNG terminals, trunk gas pipelines and necessary compression facilities for transmission and distribution of gas to the markets. The investments in the gas sector as well as rate of such investments would critically depend upon the policies being adopted in the end use sectors. In this context, the power and fertilizer sectors would influence the pace and growth of gas demand in the country. The sectoral reforms in these two sectors, pricing and tariff rationalization as well as long term fuel policy for power generation, would determine the growth of these sectors as well as the effective investment required in the gas sector. In addition to above de-regulation of these sectors, setting up of the regulatory framework and the scope of regulation would also

influence the pattern and intensity of investments in development of gas infrastructure sector.



HBJ TRANSMISSION SYSTEM

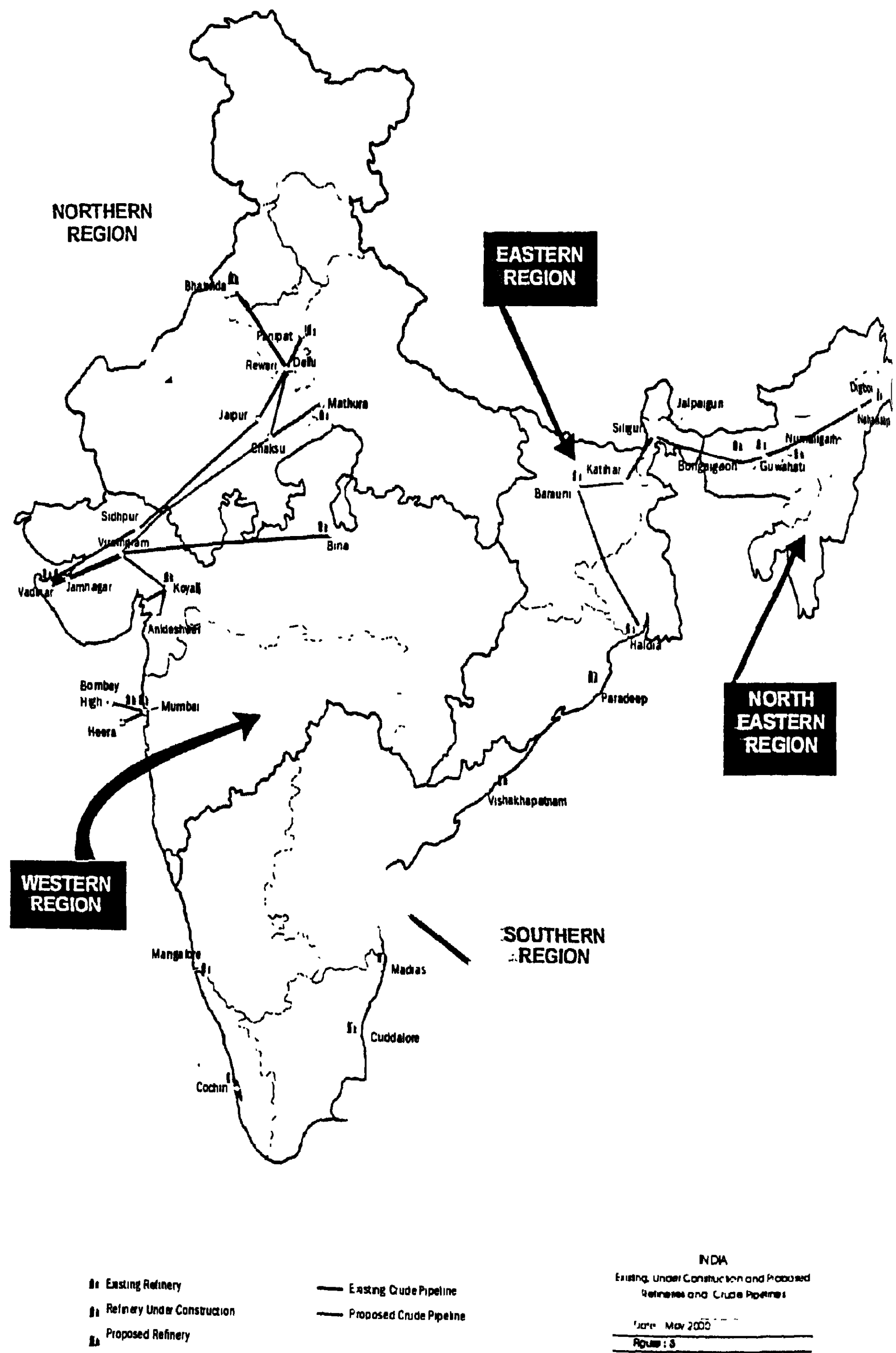
Date: May 2000

Figure: 7

Transport Infrastructure

Crude oil

Till recently, the country had only two crude pipelines: one belonging to OIL bringing north-eastern crude to Barauni refinery and the other belonging to IOC taking crude from the Gulf of Kachchh to the Koyali and Mathura refineries. The new Haldia-Barauni crude oil pipeline of 4.2 MMTPA capacity was commissioned in February 1999. IOC also completed augmentation of capacity of Salaya-Viramgram-Koyali crude oil pipeline (Salaya-Viramgram from 17.2 MMTPA to 21 MMTPA and Viramgram-Koyali from 5 MMTPA to 6.5 MMTPA) in September 1999.


NORTHERN REGION
EASTERN REGION
NORTH EASTERN REGION
WESTERN REGION
SOUTHERN REGION
Bhatinda
Panipat
Rewari
Delhi
Jaipur
Mathura
Chaksu
Sidhpur
Viramgam
Bina
Vadinar
Jamnagar
Koyali
Ankleshwar
Bombay High
Mumbai
Heera
Mangalore
Madras
Cuddalore
Cochin
Vishakhapatnam
Paradeep
Haldia
Barauni
Katihar
Siliguri
Jalpaiguri
Bongaigaon
Guwahati
Numaligarh
Digboi
Existing Refinery
Refinery Under Construction
Proposed Refinery
Existing Crude Pipeline
Proposed Crude Pipeline
INDIA
Existing, Under Construction and Proposed Refineries and Crude Pipelines
Mav 2000
Figure : 3

The capacity of the Haldia-Barauni crude oil pipeline is being further expanded from 4.2 MMTPA to 7.5 MMTPA and is expected to be completed by February 2002. The Viramgram-Mathura pipeline has also been extended to carry crude to the new Panipat refinery.

A new pipeline is to be laid from Vadinar to Bina, Madhya Pradesh to cater to the requirements of the 6 MMTPA Bina refinery, slated to commissioned by 2006/07. The 9 MMTPA proposed refinery at Bhatinda, Punjab will draw its crude requirements through a new pipeline from Mundra, Gujarat.

Petroleum products

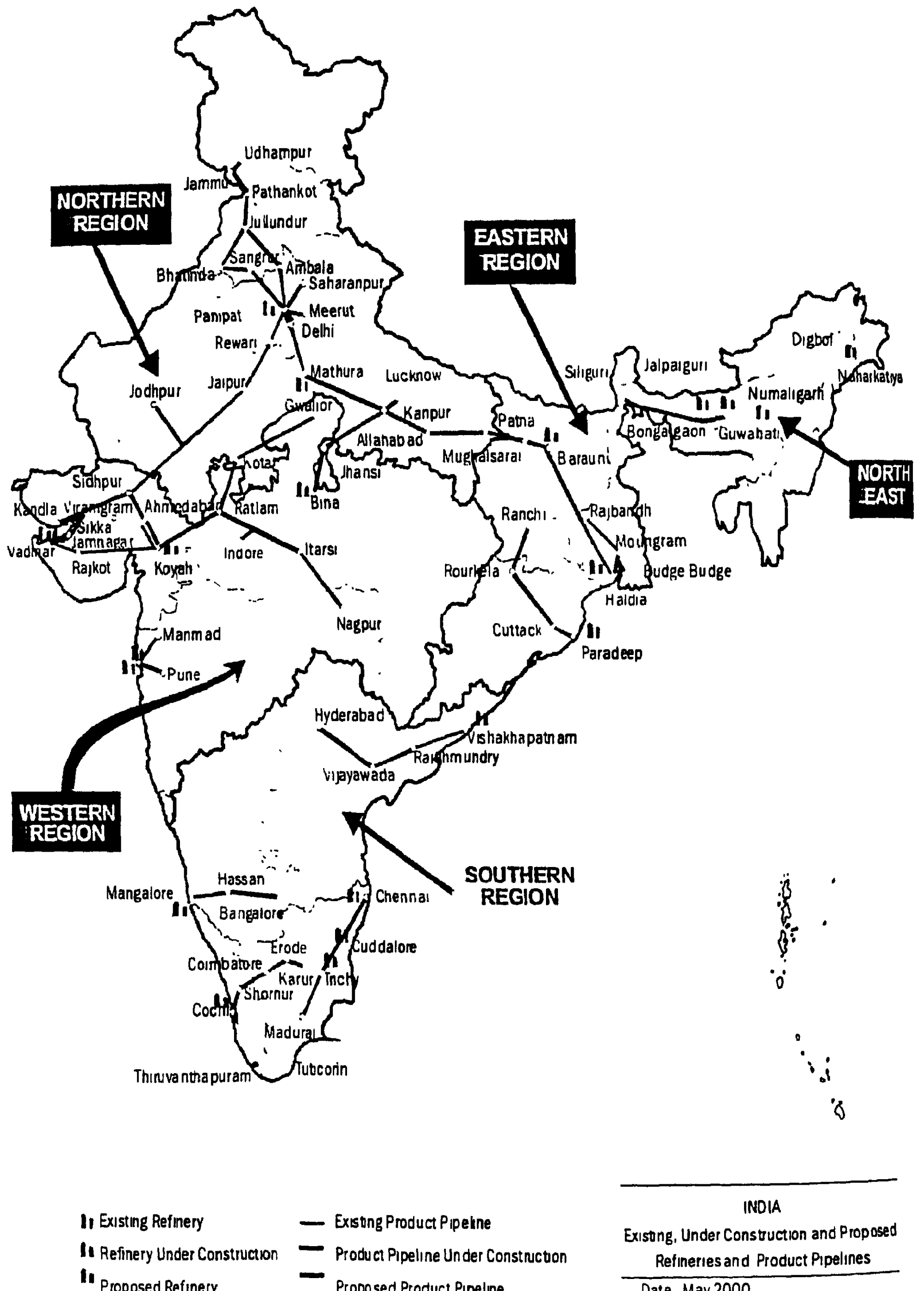
Bulk transportation of petroleum products is primarily attributed to movement by rail tank-wagons and pipelines. The share of petroleum products moved by pipeline has notched up considerably over the past four years while that of rail has declined marginally (Table1).

Table1. Transportation of petroleum products

Year	Percentage of petroleum products transported by pipeline	Percentage of petroleum products transported by rail
1995/96	21.3	40.5
1996/97	24.3	37.5
1997/98	25.1	37.7
1998/99	26.4	37.5

The share of the railways is expected to further decline in the future due to budgetary constraints in terms of procuring locomotives and tankwagons, saturation of tracks, gauge conversion, inadequate rolling stocks etc.

Considering the increasing limitations to move the products by rail, it is essential to prioritise development of pipeline infrastructure. Pipelines have the added advantage of handling sudden spurts in demand as the capacity of a pipeline can be increased with the use of chemical drag reducers. This flexibility provides tremendous advantage in maintaining supplies in case of unplanned/planned shutdown of refineries.



INDIA
Existing, Under Construction and Proposed Refineries and Product Pipelines
Date May 2000
Figure: 4

Table 2. Existing product pipeline network

Pipeline	Capacity (MMTPA)	Length (kms)	Throughput 1998/99 (MMTPA)
Gauhati-Siligun	0.82	435	1.01
Haldia-Barauni	1.25	525	1.54
Haldia-Maungram-Rajbandh	1.35	269	1.72
Barauni- Kanpur	1.80	669	1.59
Koyali-Ahmedabad	1.10	116	1.57
Mumbai-Pune	3.67	161	3.63
Mathura- Jalandhar	3.70	526	4.36
Kandla-Bhatinda	6.00	1443	5.53
Digboi-Tinsukia	0.73	75	0.47
Mumbai-Manmad	4.33	252	1.18
Vizag-Vijaywada	4.10	356	1.30
Total	28.85	4827	23.92

Source. MoPNG

Petronet India Ltd (PIL) has been formed as a financial holding company, to develop petroleum product pipeline infrastructure in the country through its joint venture companies and subsidiaries. The equity structure of the company is such that the oil PSUs IOC, HPC and BPC each have a 16% stake in the venture while IBP holds 2% stock. The balance 50% has been subscribed by financial institutions and private companies. A number of pipelines proposals have been taken up by the company. Table provides a summary of the same.

Table3. Proposed product pipelines by PIL

Pipeline	Sponsors	Completion Schedule
Cochin-Karur	PIL, BPC, CRL	November 2000
Mangalore-Bangalore	PIL, HPC, MRPL	October 2001
Chennai-Trichy-Madurai	PIL, IOC, MRL	March 2002
Central India Pipeline	PIL and oil companies	September 2002
Bina-Jhansi-Kanpur	PIL, BPC, BORL	Coincide with commissioning of Bina refinery
Bhatinda-Jalandhar-Jammu	PIL, HPC, JV refinery	Coincide with commissioning of Bhatinda refinery
Paradeep-Rourkee-Ranchi	PIL, IOC, JV refinery	Coincide with commissioning of Paradeep refinery

Port Infrastructure

Oil is handled at 13 port facilities in the country. Crude is handled at the ports of Kandla, Mumbai, Kochi, Chennai, Vizag, and Haldia, while petroleum products are handled at the ports of Mangalore, Kandla, Okha, Goa, Tuticorin, Paradeep, and Port Blair. In addition, a few products are handled at the ports of Mumbai, Kochi, Chennai, Vizag, and Haldia.

The total cargo handled by Indian ports in 1998/99 aggregated 252 MMT, of which crude and petroleum products accounted for 107 MMT. The current port infrastructure suffers from severe capacity constraints in terms of draft

availability, navigational facilities, jetty availability etc. This results not only in considerable expenditure on demurrage on coastal and foreign flag vessels but also under-utilisation of floating capacities besides substantial dead freighting. In addition the port facilities are inadequate to handle the required volume of coastal traffic.

However, since all proposed refineries are expected to have dedicated captive SBM facilities, the increase in stress on ports may not be very high. Port facilities would, however, need to cater to expansion of existing refineries without captive crude handling facilities and coastal traffic. The government needs to consider allowing oil companies to undertake projects for augmentation of the port facilities, even though the facilities are currently owned by the port authorities. Presently, access charges levied by the port authorities are quite steep and these need to be rationalised.

Major ports: capacity & traffic handled

S.NO	PORTS	CAPACITY(million tonnes)	TRAFFIC HANDLED(97-98
1.	Calcutta	7.87	7.91
2.	Haldia	17.70	20.18
3.	Paradip	10.90	13.30
4.	Vizag	31.45	36.01
5.	Chennai	25.90	35.53
6.	Tuticorin	7.60	9.97
7.	Cochin	13.46	12.17
8.	N.Mangalore	16.45	15.23
9.	Mormugao	19.18	21.18
10.	JL Nehru	9.90	8.89
11.	Mumbai	30.80	32.08
12.	Kandla	24.00	38.90
TOTAL		215	251.4

Pricing policy

The Indian economy is under-going a dynamic phase of major restructuring to integrate itself with the global economy. As a result, significant changes are taking place in the energy sector in general and hydrocarbon sector in particular.These changes have increased participation from the private sector and a phased movement towards market driven pricing regime. Aligning domestic relative prices with the international relative prices of energy is essential for removing the distortions, and hence inefficiencies, in the use of energy in the Indian economy.

Based on the recommendation of the second report of the Expert Technical Group(ETG), submitted on September 29, 1997, the Cabinet approved phased deregulation effective 1.4.1998, thereby dismantling APM for upstream

hydrocarbon sector, existing and new refineries, shipping and transportation of crude oil. The Phased dismantling of APM was announced vide GOI's Extra-Ordinary Notification No. 224 of November 24, 1997 and was implemented effective April 1, 1998.

The deregulation process commenced effective April 1, 1998 with full deregulation coming in place on April 2002. The transition period is essential to:

- Clear the existing pool deficit and Oil Bonds.
- Change the tariff structure so as to not only provide suitable and adequate protection to refining industry but also to bring it in line with other ASEAN countries.
- Reduce the subsidies in phases and bring the customer prices in line with international prices with periodic and frequent adjustment.
- Control marketing and prices of mass consumption products viz. Motor spirit, kerosene oil,LPG,ATF,HSD and NGL and to bring it to import parity levels over a period of time, in order to mitigate hardship to consumers. However, HSD and NGL, are already priced on the principle of import parity.
- Reduce subsidy on LPG in phases during the transition period through suitable increases so as to enable the prices to reach a level of 85% of import parity price by 2001-02. SKO prices should be raised in stages bringing the same to about 66.67% of the import parity prices by the end of transitionary period i.e. 2001-02. SKO and LPG subsidy, thereafter, is to be borne by the fiscal budget and the required money will be generated by levying a surcharge on MS.
- Establishment of a regulatory framework to oversee the functioning of and enforcing a competitive framework in the hydrocarbon sector.
- Providing lead-time for the establishment of infrastructure.
- Providing time to prospective entrants as well as existing players to reorient their strategies.

Natural Gas Prices

Historically, natural gas pricing was based on the Govt. awards, opportunity costs by the National Oil Companies and cost of alternate fuel to consumers.

Gas pricing came under the administrative control of the Government of India in 1986 and this was predominantly based on a cost plus approach for providing adequate returns to the producer and transmitter of gas. The consumer prices were constant over a period of time and also uniform

irrespective of the end use. From January 1992, a variable consumer-pricing concept was introduced with an annual escalation to take the consumer price close to price parity with fuel oils.

The present gas pricing regime in India is based on linkage of consumer prices to that of international basket of LS/HS fuel oil. During the current year, the parity of consumer price is 75% of average price of basket of such fuel oils. However, these prices were revised w.e.f. 1.4.2000 so as to achieve 100% fuel oil parity during 2000-01 and 2001-02. It is expected that after 2001-02, India will have gas pricing regime based on international gas pricing practices which would be regulated by the Downstream & Gas Regulatory Authority, the modalities of which are being finalised by the Government.

With effect from 1.10.1997, India's consumer price of natural gas has been linked to the price of a basket of LS/HS fuel oils as follows:

Year	General Price	Concessional Price for NE States
1997-98	55%	30%
1998-99	65%	40%
1999-2000	75%	45%

- The price of gas is fixed quarterly.
- The floor and ceiling for the general price has been fixed at Rs.2850/MSCM and Rs.2150/MSCM and for the concessional price applicable to NE States, the floor and ceiling have been fixed at Rs.1700/MSCM and Rs.1200/MSCM.
- A discount of Rs.300/MSCM is also applicable in case of gas consumers in NE States on case to case basis.
- The price of the gas so worked out has been linked to calorific value of 10,000 Kcal/SCM of gas.
- For the gas transported through HBJ pipeline, the transportation charges payable to GAIL would be Rs.1150/MSCM.
- The transportation charges are linked to calorific value of 8,500 Kcal/MSCM.
- The consumer gas prices fixed (excluding statutory levies and transportation) w.e.f. 1.10.1997, every quarter.

Gas Pricing Policy

As mentioned earlier, the present gas pricing regime in India is based on linkage of consumer prices to that of international basket of LS/HS fuel oil. While, the current consumer price (inclusive of royalty but exclusive of sales tax and

transportation charges) represent 75% of average price of basket of fuel oils, the parity is to go up to 100% by 2001-02. The producer price is derived by deducting the cost of subsidizing the gas in the NE states and the financial impact of Government's commitment to provide a higher price to the PSC operators as compared to the consumer price. Gas transportation charges for the cross-country HBJ pipeline are being fixed by the Government based on cost-plus formula to ensure a reasonable return on capital.

It is estimated that by 2011-12, about 80% of the total gas consumption in India will be sourced from imports either as LNG or piped gas. Therefore, review of the existing gas-pricing regime is required in this context. Points that need to be looked into include:

- Creation of infrastructure for transportation of gas will require enormous capital. Non-availability of financial resources could be a constraint in development of this sector, which will have many forward linkage effects. Hence, for the transporters, the pricing regime should ensure adequate financial means for creation and speedy expansion of the domestic gas transportation and marketing system.
- For the gas producers, the price should be structured not only to make the development of existing fields remunerative but also to attract risk capital for exploration and development of new fields. Needless to mention flow of risk capital in the hydrocarbon sector has to compete with other sources of energy.
- A regulator needs to be in place not only to determine adequate returns to pipelines but to also ensure that the transport companies provide the services at least cost, since pipelines are natural monopolies.
- Subsidy provided to North Eastern states needs to be reduced so as to align the price in line with international prices as it sends wrong signals to the potential investors and lead to inefficient use of gas.
- The price formula should reflect the competitive position of gas vis-à-vis other competing fuels and feed stocks.
- Educating the users of gas for the need to withdraw in-built "subsidy".
- The gas price paid should also reflect the conditions under which the gas will be delivered i.e. flexibility, steadiness of delivery profile, quality of gas, delivery point, etc.

Tariff Policy

Gas produced and sold indigenously attracts no excise or other duties except royalty and local sales/purchase taxes as applicable in different states. Details as

per the present tariff policy (1999-2000) of Govt. of India on LNG imports are as under: -

Description	BCD	CVD	SAD	NET DUTY	
LNG Import - Power	5%	-		4%	9.20%
LNG Import	5%	8%		4%	17.94%

– Others

- As may be seen from above that the net import duty payable by Power producers on imported LNG is 9.20% while LNG for other sectors attracts a net import duty of 17.94%.

Down Stream Pricing & Tariff

The Government has implemented a phased programme for dismantling of Administered Pricing Mechanism with effect from 1.4.98. As per the phased programme, the retention system of pricing for the refineries has been discontinued.

Refinery gate prices of controlled products viz. MS, HSD SKO (PDS), LPG domestic, ATF and NGL are being fixed at adjusted import parity basis for existing refineries and tariff adjusted import tariff price for the new refineries during the transition period. The refineries are free to sell all other products based on market considerations.

The Government has also decided that duty structure for crude oil and petroleum products will be rationalised in a phased manner, keeping in mind the equilibrium to be maintained between the Government revenue needs and the necessity to keep consumer prices at reasonable level. The tariff structure is also required to provide an effective rate of protection to domestic refineries and fractionators, which is reasonable but not exceeding 25%. As a step towards rationalisation of duty structure, the custom duty on crude oil has been reduced to 20%.

The Expert Technical Group had recommended a year by year rationalisation of the customs and excise duties on crude oil and petroleum products. The excise duties on petroleum products are, by and large, at the levels recommended by the Expert Technical Group except for MS and ATF. The rationalisation scheme proposed by the ETG for customs duties suggested a gradual reduction in customs duty in a manner so that the maximum rate of duty on petroleum products would be 15 per cent.

The current financial year i.e., 1999-2000, represents 2nd year of the reform process. The recommended duties and actual duties during the current financial year are as follows:

Customs duty	Per cent (97-98)	Approved by Govt.	ETG recommendation	Existing 1999-2000
Crude	27	0-5	15	20
Hsd	32	15	25	30
MS	32	15	25	30
ATF	32	15	25	30
LPG	12	10	10	10
LNG	12	0-5	0	5
FO	32	10	20	30
NAPTHA	0	5	5	5
KEROSENE	0	0	0	0
BITUMEN	32	15	25	30
OTHERS	32	15	25	30

As may be seen from above, customs duty on crude oil has to be brought down to between 0% to 5% during 2001-02. Similarly, the customs duties on transportation fuels and some other petroleum products are to be brought down within the range of 0% to 15% by 2001-02.

PROJECTS AT A GLANCE : ONGOING AND PROPOSED

ONGOING PROJECTS

Refineries	Capacity (MMTPA)	Completion Date
MRPL expansion	3 to 9	1999-2000
IOCL Koyali expansion	9.5 to 12.5	1999-2000
HPCL Vizag expansion	4.5 to 7.5	1999-2000
Numaligarh refinery	Grassroot 3	1999-2000
Reliance petroleum	Grassroot 26	1999-2000
JV IOC & Kuwait petroleum (Paradip)	Grassroot 9	2002-2003
Essar oil (jamnagar)	Grassroot 10.5	1999-2000

PRIVATE REFINERIES PROPOSALS FOR DOMESTIC TARIFF AREA

Name	Location	Capacity (MMTPA)	Approved	Investment (Rs crore)
M/s Ashok Leyland Ltd.	Paradip (Orissa)	2.00	1996	3300
M/s Essar Investment Ltd.	Vadinar (Gujarat)	9.00	1993	4050
M/s Nippon Denro	Paradip (Orissa)	9.00	1996	5400
M/s Unitel Technologies	Kakinada (AP)	1.00	1998	198
M/s Dealta	Kakinada	2.00	1998	450
M/s Pearl Petrochem	Krishnapatnam	4.00	1998	390
M/s R&H Power	Paradip (Orissa)	1.00	1998	
M/s Pelorus	Tuticorin	2.00	1998	360

OTHER PROPOSALS AS 100% EOU

Name	Location	Capacity (MMTPA)	Approved	Investment (Rs Crore)
M/s Petro Energy	Pondicherry	4.80	1994	500
M/s Aban Lloyd	Tamil Nadu	3.00	1995	1300
M/s Pennar Refineries	Tamil Nadu	2.00	1994	645
M/s East Coast Petroleum	Haldia (WB)	3.00	1997	8008
M/s Sterlite Industries	Tuticorin	3.00	1997	7113
M/s PRA Petrochemicals	Sricaculum	9.80	1997	1242
M/s Black Gold Refineries	Vizag(AP)	2.50	1993	3496
M/s Jindal Ferro	Andra Pradesh	6.00	1994	3600
M/sInternational	West Coast of Gujarat	3.00	1992	2670

LPG PROJECTS

Name	Type of Projects
Lloyds Steel Group	Storage ,distribution
Shri Shakti LPG	Port handling facility
Western India Industries Ltd.	Bottling, distribution
Hindustan Aegis(with Vitol SA)	Bottling, marketing

PIPELINE PROJECTS : FOREIGN PARTICIPATION

Indian Company	Foreign collaborator	Pipeline
Gas Authority of India ltd.	Gas de France	Bombay
Indian Oil Corporation	Betchel/ Skoda	Kandla – Bhatinda
ONGC	McDermott Int`l	Basse in Hazira

4 Power

India is a federal system with 25 States. The core legislation regarding the power sector is found in the 1910 Indian Electricity Act (IE Act) and the 1948 Electricity Supply Act [E (S) Act] and related regulations and notifications. Prior to independence, the power sector largely comprised licensees that operated under the authority of the IE Act, which also provided for such matters as consumer protection and operational safety. The post-independence E(S) Act fundamentally restructured the industry, requiring state governments to create State Electricity Boards (SEBs) or a suitable alternative. The Industry Policy Regulation of 1956 reserved generation and distribution for the public sector and hence led to the gradual nationalisation of the power sector.

The E(S) Act also created the Central Electricity Authority (CEA) within the Ministry of Power (MoP). The MoP with the technical assistance of CEA has broad authority to determine the power sector policy and is the link between central government ministries and state governments. The State governments in turn have broad influence over the activities and finances of the SEBs. Under section 3(1) of Act CEA is charged with following functions:

- Development of national power policy, formulate short-term and perspective plans for power development and co-ordinate the activities of planning agencies in relation to the control and utilisation of national power resources
- Collection and recording of data concerning generation, distribution and utilisation of power and carry out studies relating to cost, efficiency, losses and benefits
- To make public, from time to time information secured under the Electricity Supply Act 1948 and provide for the publication of reports and investigations
- Techno-Economic appraisal of power projects
- Promotion of inter-sate and joint venture power projects.
- To carry out any investigation for the purpose of generation and transmission of electricity
- To promote and assist in the timely completion of projects sanctioned
- To advise any State Government, SEB, Generating Company or any other agency engaged in generation or supply of electricity on such matters as will

enable such government, SEB, Generating Company or agency to operate and maintain the power system under the ownership or control in an improved manner and where necessary in co-ordination with any other agency owning or having the control of another power system

In the years after independence, the power sector continued to evolve, as the following examples. In 1960, the Central Power Research Institute (CPRI) has been established with the setting up the institute was to serve as an independent National Laboratory for under taking applied research electric power engineering besides functioning as an independent National testing and certification authority for electrical equipment and components manufactured in the country for quality assurance and performing tests for product development.

In 1969 The Rural Electrification Corporation (REC) was established to provide financial assistance to specific projects of rural electrification, energising pump sets for irrigation purposes and to provide power to agriculture based small-scale industries. It also assists State Electricity Boards in schemes for improvement of system performance and small generation projects like wind energy and hydel projects.

Central generating Companies were allowed after 1975. The National Thermal Power Corporation (NTPC) and National Hydroelectric Power Corporation (NHPC), which builds and operates major generating stations that sell to several states, is an important examples. North Eastern Electric Power Corporation (NEEPCO) was set up in 1976 with the objective of construction and operation of power projects in the North-eastern region. Prior to these central generating stations, Damodar Valley Corporation (DVC) was established in 1948 with objectives of Flood control, irrigation and water supply for industrial and domestic use, generation, transmission and distribution of electrical energy, promotion of afforestation and control of soil erosion in the Damodar Valley and promotion of industrial, economic and general well-being of the people in the Damodar Valley and its areas of operation. The other central generating companies are Nathpa Jhakri Power Corporation Limited (NJPC) and Tehri Hydro Development Corporation (THDC), which are responsible for harnessing hydro-electric power in the Satluj water river basin in Himachal Pradesh and development of hydro electric projects in Bhagirathi Bhilangana Valley in Uttar Pradesh respectively. Bhakra Beas Management Board (BBMB) is also central generating company which is responsible for the administration, maintenance and operation works at Bhakra Nangal project, Beas Project unit I and II

including Power Houses and network of transmission lines and grid sub-stations under its areas of operation.

The Power Finance Corporation (PFC) was established in 1986 to function as the prime development Financial Institution dedicated to the growth and overall development of the Power sector. The borrower portfolio of PFC comprises the State Electricity Boards (SEBs), State generation corporations, Municipality-run power utilities, besides central and private power utilities. The funds provided by the Corporation are in the nature of additionally to the Central Plan allocation (in respect of SEBs, etc.) and based on the merits of the individual projects.

In 1989, Power Grid Corporation was created, primarily to integrate the five regional grids into a unified national system.

National Power Training institute was set up by the MOP to function as national apex body for the Human Resources Development of Power sector personnel in the country.

In 1989 Energy Management Centre was set up as an autonomous organisation with the objective of strengthening energy management capabilities in the country. It implements programmes and policies of Ministry as well as provides technical support to the Ministry on matters relating to end use energy efficiency and conservation. The prime role of EMC is to promote and co-ordinate initiatives for all end uses of all sources of energy with a view to provide thrust in energy conservation activities in the country.

In 1999-2000, a Power Trading Corporation (PTC) was set up for the purpose of buying power from mega power projects under long-term power purchase agreements (PPA) and sells it to the beneficiary States under the long-term PPA. Security to the PTC would be provided by means of letter of Credit and recourse to the share of Central Plan' allocations and other devolution's.

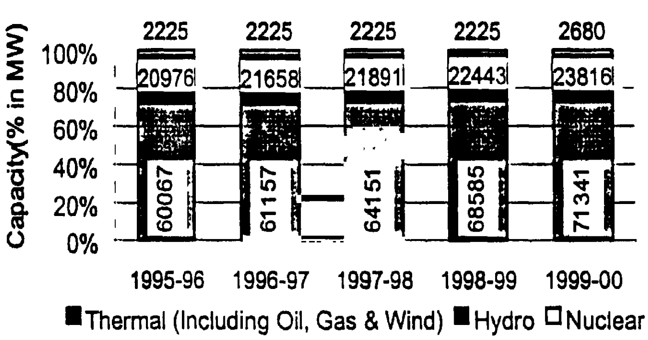
In 1998, the Central Electricity Regulatory Commission (CERC) was set up under the provisions of Electricity Regulatory Commission Act, 1998 as an independent statutory body with quasi-judicial powers. The CERC has the responsibility of discharging the following functions:

- To regulate the tariff of generating companies owned or controlled by the Central Government
- To regulate the tariff of generating companies other than those owned or controlled by the Central Government if such generating companies enter into or otherwise have a composite scheme for generation and sale of electricity in more than one State.

- To regulate inter-state transmission of energy including tariff of the transmission utilities
- To promote competition, efficiency and economy in the activities of the industry
- To aid and advise the Central government on formulation of tariff policy and frames the guidelines pertaining to tariff
- To associate with environmental regulatory agencies to develop appropriate policies and procedures for environmental regulation of the power sector
- To license any person for the construction, maintenance and operation of an inter-state transmission system
- In the States, SERCs (State Electricity Regulatory Commissions) has been established to rationalise the tariff structure, improve the financial health of their SEBs (State Electricity Boards), etc.
- In 1991, as part of the overall economic liberalisation programme in India, domestic and international private sector participation in the power sector was permitted.
- Private utilities form the smallest part of the power sector in India. The private sector organisations in the power sector have performed consistently well. They have generally been profit-generating organisations and are now regarded as role models for the new companies entering the sector. The major players in the private sector have been the Bombay Suburban Electric Supply Company (BSES) distributing electricity in the Mumbai City (in the state of Maharashtra), Calcutta Electric Supply Company (CESC) in Calcutta (in the state of West Bengal), Tata Electricity Company (TEC) in Mumbai (in the state of Maharashtra), Ahmedabad Electric Company (AEC) in Ahmedabad (in the state of Gujarat), Surat Electric Company in Surat (in the state of Gujarat) and NOIDA Power Company (in the State of Uttar Pradesh).
- With the result of power sector reforms in the State of Orissa, all the four distribution zones have been awarded to the private sector licensees. These include; BSES has been awarded three zones (Western, Northern and Eastern) and the Central Zone to the AES Corporation of USA.
- Installed Capacity and its mix
- The total installed capacity (utilities) has grown from approximately 1300 MW in 1947 to 97837 MW by the end of the FY 1999-2000 (Table 1). These include the central sector, the state owned and private sector plants. The generating capacity of utilities comprises a mix of hydro, coal/oil/gas/wind based thermal and nuclear plants. Up to mid 1960s, the thrust was more on

developing hydro projects but since 1970s the thermal capacity, inclusive of gas, has shown remarkable increase and now stands at approximately 73%. The share of hydropower rose to 46% in 1966-67, but has been steadily declining since then due to various reasons. These include inter-state water sharing issues, long gestation periods, unknown geological surprises, lack of demand in home-states, increase in awareness on environmental concerns and social impact due to large-scale displacement of people from their natural habitats, submergence of monuments, silting etc. The share of hydropower in the total capacity at the end of 1999-2000 was about 24%. The share of nuclear power is approximately about 2.7%. During the past five years only 440 MW of nuclear power capacity has been added to the grid. Chart 1 below demonstrates the mix of different fuels in the generating capacity for the last five years. Table 1 provides the details of state-wise and fuel-wise installed capacity as on 31st March 2000.

Chart 1: Mix of different fuels in the generating capacity for last five years.



More than 90% of the generating capacity under utilities is owned by the public sector utilities. While the central sector utilities own approximately 30.0% of the total capacity, the share of private sector is only about 8.0%. During the Ninth five-year plan (1997-2002,) it was planned that additional capacity of about 40,245 MW would be set up in the country. According to the mid-term review of the Ninth five-year plan, only 28097 MW of the targeted capacity is expected to achieve at the end of the Plan. Private sector is expected to contribute about 8363 MW and thus play a major role in the development of the sector. The list of generation stations (above 50 MW) as on 31 March 1997 is given in the Table 2.

Transmission Infrastructure

The PGCIL was established in 1989 pursuant to the government objective of establishing a national power grid. It also develops schemes for strengthening of the regional grids and establishing inter-regional links. An inter-regional links, connecting western and northern regions through a 2x250 MW HVDC back-to-back station at Vindhyachal, 2x500 MW HVDC back-to-back connecting western and southern regions and 500 MW HVDC back-to-back connecting at eastern and southern regions at Gazuwaka are already in operation.

There were 36,166 circuit km of 400 kV, 80,039 circuit km of 230/220 kV and about 79134 circuit km of 132 kV transmission lines operating in the country at the end of the FY 1996-97. These are collectively owned by the PGCIL and the SEBs. The total line length inclusive of the low-tension distribution lines at the end of same period was more than 5 million-circuit km. The state-wise length of T&D lines is given in the Table 4.

Rural electrification

The growth of transmission and distribution network has enhanced increase in the number of towns and villages electrified. As on March 1999, all the urban areas and about 85% of the villages (over 5 million) have been electrified in the country. The total number of pump-sets energised as on March 1999 were 12.21 million, which lead to a growth in agricultural production. About 7.3 million pump-sets are yet to be energised. The State-wise number of villages electrified and pump-sets energised are given in Table 5.

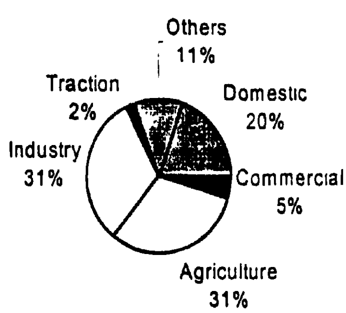
Sectoral Electricity Consumption

The consumption of electricity in India has experienced a rapid growth during the current decade. The average consumption rate has increased to 7% during the current decade with the year 1999-2000 recording a growth of 9.6%. The per capita consumption has increased from 253 kWh in 1990-91 to 334 kWh in 1996-97 registering an annual growth rate of 6.5%. The number of consumers during the same period has grown from 69 million to 95 million.

Industry was the single largest consumer of electricity over the years 1992-93 to 1998-99. It accounted for approximately an annual average of 35 % of the total sales of electricity by the utilities. During the later two years, 1997-98 and 1998-99, due to increase in captive power consumption in the industries resulted significant reduction in power sales by the utilities to the industrial sector. Next to the industry, Agricultural sector has become the largest consumer of electricity in the country. In 1998-99, electricity consumption in

both industry and agricultural sector are equally accounted to be 31% of the total electricity sold by the utilities. During the same period, in the States of Rajasthan, Punjab, Maharashtra, Andhra Pradesh, Madhya Pradesh, Gujarat, Haryana and Karnataka, 32 -44% of the electricity was sold to the agriculture sector alone. The State-wise details of category-wise consumption are given in Table 6. The chart 2 below depicts the consumption of electricity in various consumer segments during 1998-99.

Chart 2. Sectoral consumption of electricity during 1998-99



Hydroelectric potential in India

India has vast hydroelectric potential especially in North and North-Eastern regions. The all India hydroelectric potential has been assessed at 84,044 MW at 60% load factor. A total of 845 hydro electric schemes have been identified in the various basins and the annual energy contribution from these schemes is expected to be about 600 TWh including seasonal energy generation. However, the assessed potential does not include the contribution from small schemes like small rivers/streams, canal falls etc. which has been undertaken separately by the Central Electricity Authority. As on March 1996, only about 14.8% of the total potential have been developed and about 7% of the total potential is under development. As compared to the North, North-Eastern and Eastern regions, Southern and Western regions have exploited about 49% and 32% of the regional potentials respectively (Table 1). However, issues like resource constraints, long gestation period, unknown geological surprises, lack of demand in home states, inter-state water sharing and power sharing disputes, etc. the potential could not be exploited fully.

Power Supply Scenario

During 1999-2000, the all India energy requirement was 480 billion units and the peak demand was 72669 MW. Against these figures, the available energy was 451 billion units and peak demand met was 63691 MW, leading to an energy deficit of 6.2% and peak deficit of 12.4%. In comparison to the corresponding figures for 1998-99, the energy deficit had increased by 0.3 %, while the peak deficit had reduced by 1.5%. A summary of the power supply scenario over the last eight years (1992/93-1999/2000) reveals that peak shortages have been much more sharper than the energy shortages.

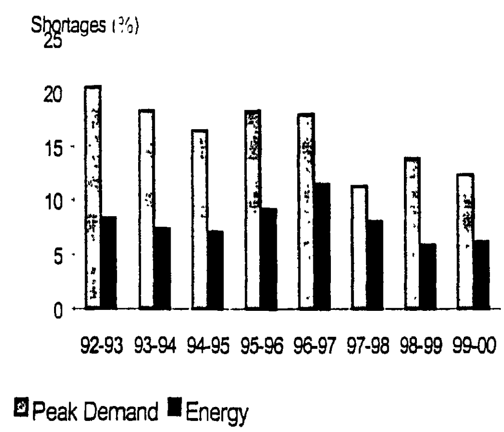


Figure 1. Power supply scenario

Source: MoP (2000, Annual report), CEA

Thermal plant performance

The key indicators of any thermal power plant performance include Plant Load Factor (PLF), auxiliary consumption and fuel consumption.

In the recent years, the all India PLF has improved. However considerable inter-state variations exist. The PLF in the Eastern and North-Eastern regions has consistently been low compared to Northern, Southern and Western regions. The central and private sector plants have better PLF than the state sector plants. Inappropriate quality of coal, age and size of units, equipment deficiency and failure of the units due to low load are major causes for low PLF. The all India (PLF) during 1998-99 was 64.6% (Table 3). The all India PLF for the period April 1999 -January 2000 was 66.1%, which was 3.3% more than the target of 62.8% for this period.

During the nineties, the weighted average auxiliary consumption of thermal and hydel plants for the entire state sector has remained same in the range of 7-8 % of the gross energy generated. The states like Bihar, Orissa and West Bengal, the auxiliary consumption is higher than the national average. The auxiliary consumption in thermal generation is higher than the hydel generation.

In the state sector thermal plants, the specific coal consumption per unit of electricity generation has varied in the range of 0.75 kg to 0.78 kg over the years during the period from 1992-93 to 1999-2000. The specific secondary oil consumption in the coal based thermal units increased sharply from 0.78 ml/kWh in 1992-93 to 10.8 ml/kWh in 1995-96 and then decreased to 5.38-

ml/kWh during 1998-99. It is expected to be about 6 ml/kWh in 1999-2000 (Table 6).

Transmission and distribution losses

The all India average reported Transmission and distribution losses for the year 1998-99 and 1999-2000 was 23.2% and 22% respectively (Table 5). However, large variations occur between the states.

Initiation of the reform process has resulted in a re-assessment of the transmission and distribution losses, in most states. Consequent to re-assessment most states have reported significantly higher losses than have been heard of in the past. For example, in the states of Andhra Pradesh, Haryana and Uttar Pradesh, the T&D losses are estimated to be in the order of 51%, 40% and 42% respectively as against the reported losses of 25%, 32% and 27% before restructuring (Feb 2000, Power Ministers conference, Ministry of Power). Inadequate investments on T&D facilities and lack of proper distribution planning are the major factors that have contributed to the high level of technical losses. In addition to these, defective metering, un-metered supply and pilferage have resulted in the very high non-technical losses that are so rampant in most of the states.

Captive generation

Industrial sector is the largest consumer of electricity. Besides, purchasing power from utilities, a number of industries namely aluminium, cement, fertilizer, iron, steel, paper, sugar, etc have their own captive power plants. According to CEA, the all India installed capacity of non-utilities with capacity greater than 1 MW was of the order of 9168 MW during1991-92. This capacity increased to 11916 MW and yielded a generation of about 40 billion units during 1996/97.

According to an independent resource[a], the total tracked captive capacity has been identified to be of the order of 14705 MW. This accounts nearly 15% of the total installed capacity of 1999-2000. The states of Gujarat, Orissa, Tamil Nadu, Madya Pradesh, Andhra Pradesh, Uttar Pradesh and Karnataka account for about 72% of this tracked capacity.

[a]Power Line Research. 1999 Captive report published in September 1999

Consumer category-wise average tariff

The average revenue realized per unit from the agricultural and domestic categories is lower than the overall average revenue realized per unit of supply (Tables 10 &10A). The electricity charged for the consumer categories namely; commercial. Industrial and railway traction are significantly higher than the average tariff. The average tariff for sale of electricity by the SEBs increased from 193 paise / kWh to 207.8 paise / kWh during 1998-99 to 1999-2000. However large variations exist within the states.

5 Renewable energy and government structure

Though renewable energy technologies (RETs) such as biogas plants and improved cook stoves had been available in India since the late 1940s, the program itself was initiated on a very moderate scale in the wake of the energy crisis of 1973. Government of India set up a high-powered CASE (Commission for Additional Sources of Energy) to draw up plans for achieving a harmonious transition from an economy based on hydrocarbons to one based on renewable energy resources. To provide focussed attention to this sector, a separate Department of Non-conventional Energy Sources was also created in 1982, under the Ministry of Energy, at par with Departments of Coal and Power. After a decade, in 1992, the Department was upgraded to the status of a Ministry, named the MNES (Ministry of Non-conventional Energy Sources) to increase the deployment of renewable energy technologies. Following table provides a brief history of RE sector governance and policy initiatives:

Table: RE sector governance and policy initiatives

Year/Period	Department	Action
1970	FPC recommendation	RE sources first recognised and incorporated in an official policy document
1970s	Following oil-shock	RE policy and planning received a further push for increased R&D and promotional
5th five year plan		National project for biogas development (NPBD) launched target set for
6th five year plan		Official emphasis on RE sources on a permanent footing separate heading for new
1981		RE became an integral part of the Prime Minister's 20 point programme.
1982	Establishment of DNES	Department of Non-conventional energy sources (DNES), an exclusive
7th five year plan		A national level programme on social forestry and improved cooking was launched
1987	Establishment of IREDA	Indian Renewable Energy Development Agency (IREDA), set up by DNES, to
8th five year plan		Shift of emphasis towards market orientation and commercialisation of technolog
1992	DNES to MNES	DNES was given the permanent status and was converted into the Ministry of Non-conventional Energy Sources (MNES)

Till mid 1993, the MNES was organized broadly based on technology, individual technologies were promoted through design and development support, and through the establishment of large-scale demonstration programmes, e.g., the national programmes for biogas development, cookstoves dissemination, and wind energy. Through these programmes, a RET manufacturing base was created. The RET devices were procured by the

government, either for demonstration projects (as for wind energy and for SPV community-lighting and power plant programmes), or for subsidized sales to consumers. A number of technology-support centres were created to promote technological up gradation by manufacturers, and to certify the quality of devices procured by the government. The devices and the subsidies were channeled to consumers through **SNA (State Nodal Agencies)** that were responsible for after-sales service and consumer support.

In order to give the required focus on commercialization, market orientation, and in order to have greater involvement of the private sector, the MNES was restructured in 1993 on the basis of end-use applications of technologies through horizontal integration of various technologies. The restructured MNES now has sectoral groups of:

- Rural energy
- Urban/industrial energy, and
- Power generation.

Under the New Strategy and Action Plan of 1993, the following, two-pronged Action Plan was devised:

- High priority accorded to generation of grid quality power from wind energy, small hydropower, bio-energy and solar energy.
- Rural energisation programme is promoted through:
  - electrification of villages through photovoltaic and biomass gasifier power systems
  - supply of solar lanterns to unelectrified households
  - use of solar water heating systems
  - rural energy programmes viz National Project on Biogas Programme
  - production of energy from agricultural waste, etc.

Currently, a three-fold strategy has been pursued by the government for promotion of RE sources through private sector involvement. These include:

- Providing budgetary resources by government for demonstration projects.
- Extending institutional finance from the *Indian Renewable Energy Development Agency (IREDA)* and other financial institutions for commercially viable projects, with private sector participation; and external assistance from international and bilateral agencies.
- Promoting private investment through fiscal incentives, tax holidays, depreciation allowance, facilities for wheeling and banking of power for the grid and the remunerative returns for the power provided to the grid.

The emphasis has shifted from direct financial incentives (e.g., capital subsidies) to indirect fiscal incentives (e.g. low interest loans, financing packages for consumers, reduced tariff and taxes, viable power-purchase prices, etc.). This has stimulated private-sector investment in wind and SPV power plants, as well as encouraged RET manufacturers and financing intermediaries to address the needs of consumers in their product design and system development. The current policy environment has been successful in creating one of the largest and most diverse renewable energy programs in the world, with a broad technological base and large human capacity.

IREDA (Indian Renewable Energy Development Agency Limited) was established in March 1987 as a public sector enterprise for the promotion, development, and financing of new and renewable sources of energy technologies. As on 31 December 1998, the cumulative sanctions by IREDA amounted to 23.79 billion rupees and the disbursements were 99.03 billion rupees. Concomitantly, this was accompanied by financial and technical assistance from the World Bank, the UNDP (United Nations Development Programme), the GEF (Global Environment Facility), and the Asian Development Bank.

Estimated potential of RETs

Table. Estimates of technical potential for renewable energy technologies

Source/Systems	Approximate potential
Biogas plants (nos.)	12 million
Improved cook stoves (nos.)	120 million
Biomass energy	17000 MW
Solar energy	20 MW/sq. km.
Wind energy	20000 MW
Small hydro power	10000 MW
Ocean energy	50000 MW

Wind energy

The wind power potential initially estimated at 20,000 MW has now been revised to 45,000 MW considering the technological advances and availability of modern equipment. The present installed capacity of wind represents a little over of 1% of the total installed power generating capacity in the country. More than 5 billion units of electricity has been generated and fed to the state grids from wind power plants.

Potential windy locations had been identified in the coastal region of southern Tamilnadu, Kerala, Gujarat, Lakshadeep, Andaman and Nicobar

Islands, Orissa and Maharashtra. Some locations have also been identified in certain parts of Karnataka, Andhra Pradesh, Madhya Pradesh, Tamilnadu, West Bengal, Uttar Pradesh and Rajasthan.

Solar photovoltaic systems

Indian PV market can be divided as follows:

- MNES supported subsidy market primarily for socially driven schemes
- Commercial market for specialized applications such as in railways, telecommunications, and exports
- Consumer oriented market primarily driven by availability of finance

The first segment of market consists of approximately 30% of the aggregate system installed capacity. Market share for commercial segment has been 46%, and remaining 24% is accommodated in the consumer oriented market. In view of the current emphasis and commitment on deploying the PV technology through commercially sustainable routes, it is estimated that the market segment in the commercial and consumer segments will grow as fast as the growth projected in the government sector.

Of the several applications of PV, home systems for lighting with some additional power is emerging as the largest market. Market potential is unlimited in the above segment as unelectrified as well as electrified but poorly serviced areas of rural and urban sectors represent this segment.

Table. Structure of Indian PV market

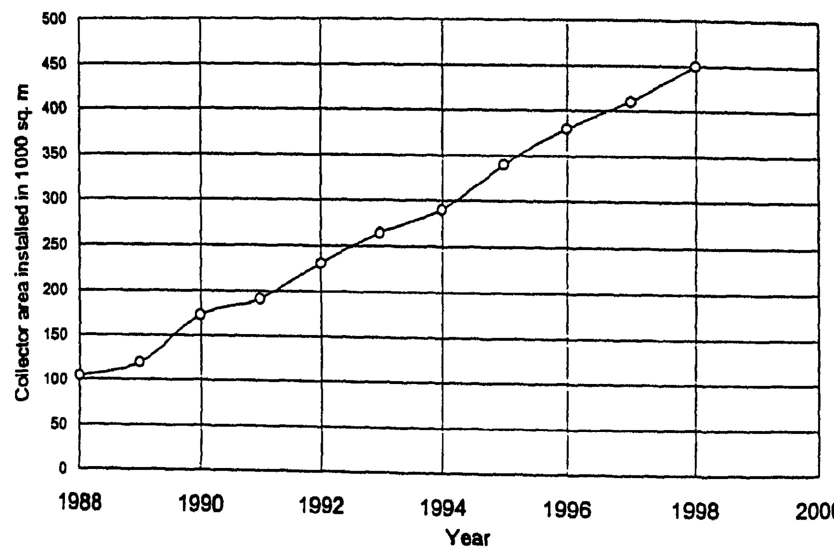
Market segment	System/product	Percentage sha
Minimum rural energy needs	Lantems	5.16
Decentralized energy supply	Power plants for Rural electnfication	2
Grid connected power generation and	Centralized power plants	2.1
Others and exports	Telecommunication equipment, Systems for	69

Total installed capacity: 58 mw (totaling 750,000 systems)

Solar water heating

A solar water heater serves the functions of collecting solar energy, utilizing this energy to heat water and storing hot water. The circulation of water in the system is possible due to the density difference or by utilizing a pump.

Figure. Cumulative growth in solar thermal systems (installed collector area)



In India, solar thermal systems are used for heating water for domestic and industrial purposes. In the industrial sector, these systems preheat boiler feed water and also supply direct process heat. The resultant savings are mainly in terms of boiler fuel. In the domestic sector, solar water heating systems primarily replace electric geysers. The small capacity systems (up to 2000 litre per day) work on natural circulation or thermosyphon principle. However, for larger capacity systems, pumps with necessary controls are required to circulate water and such systems are designated as 'forced flow' systems. The cumulative installed collector area in the country in 1998/99 was 450 000 m^2.

Biomass power

Biomass includes straw, stalks, stems and fines, agro-industrial processing residues such as shells, husks, deoiled cakes, forestry residues and biomass grown in specially dedicated energy plantation. Conversion technologies include combustion/inceneration, , gasification, pyrolysis etc.) using gas/steam turbine, dual fuel engine/gas engine, or combination thereof, either in power alone or in co-generation (of more than one energy forms - steam and power) mode.

Co-generation

Co-generation i.e. multiple and sequential use of a fuel for production of steam and power in a process industry, aims at surplus power generation in industries such as sugar mills, paper mills, rice mills, etc., where biomass resources are either generated or consumed in their main processing/production process.

Potential - 19,500 MW

Table. Status of biomass power installations

Commissioned projects	222.0 MW	40 projects
Biomass power	39.0 MW	10 Projects
CO-generation	183.0 MW	30 Projects

Table. State-wise List of Commissioned Biomass Power Projects (in MW)

2.	Gujarat	--	--	--	--	--	--	0.5	--	0.5
3.	Haryana	4.0	--	--	--	--	--	--	--	4.0
4.	Karnataka	--	--	--	--	1.0	--	10.0	26.0	37.0
5.	Maharashtra	1.5	--	1.5	4.5	1.5	--	--	--	9.0
6.	Madhya Pradesh	--	--	--	--	--	--	5.0	--	5.0
7.	Punjab	--	10.0	--	--	--	--	--	--	10.0
8.	Tamil Nadu	3.0	3.0	1.0	19.0	25.5	33.5	10.0	--	98.0
9.	Uttar Pradesh	--	--	--	6.5	--	[illegible]	8.0	[illegible]	[illegible]
		8.5	13.0	5.5	30.0	29.0	41.5	43.5	[illegible]	[illegible]

Small hydel

Ministry of Non-conventional Energy Sources (MNES) has so far been responsible for small and mini hydro projects up to 3 MW station capacity. The subject of small hydro between 3-25 MW has recently been assigned to MNES.

India has 263 small hydropower projects up to 3 MW station capacity with an aggregate capacity of over 202 MW. These projects are spread throughout the country in hilly regions as well as on canal drops. Over 150 projects in this range with aggregate capacity of 145 MW are under construction.

The small hydropower projects are developed in the potential regions by the State Electricity Boards/ State Agencies responsible for SHP development. Most of the SHP projects are grid connected. However, there are some projects, which are decentralized and are managed by local community/ NGOs.

Table. Identified small hydro potential sites in india (Up to 3 mw capacity)

Sl.No.	Name of State	Identified Sites	Project capacity
1	Haryana	21	24.05
2	Himachal Pradesh	166	216.03
3	Jammu & Kashmir	106	145.52
4	Punjab	78	65.26
5	Rajasthan	49	27.26
6	Uttar Pradesh	310	326.63
7	Gujarat	283	113.33
8	Madhya Pradesh	99	74.63
9	Maharashtra	183	123.57
10	Andhra Pradesh	271	114.88
11	Karnataka	181	166.11
12	Kerala	167	199.10
13	Tamilnadu	131	141.92
14	Bihar	158	199.37
15	Orissa	152	88.76
16	Sikkim	52	56.25
17	West Bengal	141	153.87
18	Arunachal Pradesh	433	382.31
19	Assam	38	50.00
20	Manipur	91	59.75
21	Meghalaya	83	41.00
22	Mizoram	73	42.32
23	Nagaland	67	26.89
24	Tripura	8	9.85
25	A&N Island	5	1.15
26	Goa	3	2.60
	Total	3349	2852.41

Rural energy

National Project on Biogas Development (NPBD), which caters to family type biogas plants. It was started in 1981-82 with the following objectives:

- To provide fuel for cooking purposes and organic manure to rural households through biogas plants.
- To mitigate drudgery of rural women, reduce pressure on forest and accentuate social benefits
- To improve sanitation in villages by linking toilets with biogas plants.

Table. Cumulative achievement under NPBD, against estimated potential of biogas plants (up to 31st March 2000)

State/UTs	Number of Biogas plants		
	Estimated potential	Installed during 1981-82 to 1999-2000	Coverage of estimated potential in %age
Andhra Pradesh	10,65,600	2,82,557	27
Arunachal Pradesh	7,500	742	10
Assam	3,07,700	41,896	14
Bihar	9,39,900	1,16,621	12
Goa	8,000	3,188	40
Gujarat	5,54,000	3,35,315	61
Haryana	3,00,000	39,865	13
Himachal Pradesh	1,25,600	42,547	34
Jammu & Kashmir	1,28,500	1,862	1
Karnataka	6,80,000	2,77,561	41
Kerala	1,50,500	64,816	43
Madhya Pradesh	14,91,200	1,78,304	12
Maharashtra	8,97,000	6,47,443	72
Manipur	38,700	1,793	5
Meghalaya	24,000	1,279	5
Mizoram	2,200	1,976	90
Nagaland	6,700	1,097	16
Orissa	6,05,500	1,60,010	26
Punjab	4,11,600	56,348	14
Rajasthan	9,15,300	65,185	7
Sikkim	7,300	2,494	34
Tamilnadu	6,15,800	1,96,545	32
Tripura	28,500	1,164	4
Uttar Pradesh	20,21,000	3,40,312	17
West Bengal	6,95,000	1,68,297	24
A & N Islands	2,200	137	6
Chandigarh	1,400	97	7
Dadra & Nagar Haveli	2,000	169	8
Delhi	12,900	673	5
Pondicherry	4,300	539	13
Total	1,20,49,900	30,30,832	25.15

Table. Cumulative achievement up to 31st March 2000 under Community, Institutional & Night Soil based Biogas Plants Programme

State/U.T.	Number of CBP/IBP/NBP Installed
Andhra Pradesh	105
Assam	2
Bihar	37
Goa	20
Gujarat	147
Haryana	41
Himachal Pradesh	7
J&K	4
Karnataka	48
Kerala	45
Madhya Pradesh	116
Maharashtra	413
Manipur	4
Meghalaya	2
Nagaland	7
Orissa	33
Punjab	558
Rajasthan	55
Tamil Nadu	201
Uttar Pradesh	1146
West Bengal	51
Delhi	32
Pondicherry	1
Total	3,075

Municipal and solid wastes

Under *National Programme on Energy Recovery from Urban, Municipal and Industrial Wastes* 4 nos. of power generation plants of aggregate capacity 8.45 MW have already been completed and 9 waste-to-energy project proposals are under development.

Potential

A potential for generating about 1000 MW of power from urban and municipal wastes and about 700 MW from industrial wastes is estimated for the country. This potential is likely to increase further with economic development.

National Programme on Improved Cookstoves

Improved cookstoves (chulhas), aimed at enhancing the energy efficiency of biomass burning, and eliminating the smoke from the kitchen environment, had been in vogue in India since late 1940s. However, concerted efforts to promote the technology in the rural areas began only in the early 1980s in the wake of the

realization of the rural energy crisis. Improved Chulhas (ICs), along with biogas, was one of the earliest technology dissemination programmes launched by the Department of Non-conventional Energy Sources (DNES). Starting as a demonstration programme in 1983-84, the National Programme on Improved Chulhas was launched in 1984/85. The objectives of the programme are: (i) fuelwood conservation; (ii) removal/reduction of smoke from kitchens; (iii) check on deforestation and environmental degradation; (iv) reduction in the drudgery of women and girl children and consequent health hazards; and (v) employment generation in rural areas. In the country, over 80 models of fixed and portable improved chulhas are available for family, community and commercial cooking applications.

A large infrastructure is also in place by way of Technical Backup Units (TBUs), which are expected to provide R&D and training support in various states.

Cumulative achievement is over 322 lakh improved chulhas up to 31st March, 2000. The details installations in each state are provided in Table. However, an evaluation study by the NCAER (National Council for Applied Economic Research), for the period 1992–95, revealed that while 71.8% of the cookstoves installed during the previous three years were functional, (1) nearly one-fourth of the chulhas installed stopped functioning within a year of their installation, (2) the maintenance of chulhas by beneficiaries was poor, and (3) the number of self-employed workers and their competence was short of the requirements.

6 Environment

Organisation structure of the environment sector in India

The Ministry of Environment and Forests (MoEF), constituted in 1985 is the nodal agency in the administrative structure of the Central Government responsible for protection and management of environment in the country. It is also entrusted for the planning, promotion, coordination and overseeing the implementation of the various environmental and forestry Programme. Different ministries, boards and organisations those are responsible for protection and management of environment are shown in Figure 1. The MoEF, Central Pollution Control Boards (CPCB) and State Pollution Control Board (SPCB) form the regulatory and administrative core, while other ministries and bodies are also involved through various functions, policies and schemes to promote environmental management. In addition, there is a network of government and non-governmental institutions, organisations and laboratories that are involved in monitoring, reporting and studying environmental pollution and management. The ministry has also designated as the nodal agency in the country for the United Nations Environment Programme (UNEP) International Centre for Integrated Mountain Development and looks after the follow up of the United Nations Conference on Environment and Development.

The CPCB and SPCBs were set up under the Water Act of 1974 for controlling and monitoring of environmental degradation in the country. The CPCB was established for the purpose of implementation of the Water Act. The responsibilities of MoEF, CPCB and SPCB and their regional offices are given in Figure 2. The reporting system existed as part of monitoring and management practices is also shown.

The Eleventh Schedule of the 73rd Constitutional Amendment in 1992 has empowered Panchayat bodies and bestowed with responsibilities in the areas of soil conservation, water management, watershed development, social and farm forestry, drinking water fuel and fodder, non conventional energy sources and maintenance of community assets. Urban local bodies are empowered under the 74th Constitutional Amendment in 1992 to protect environment and promotion of ecological effects. The National Environmental Appellate Authority (NEAA) was set up in 1997 to act as vigilant body to deal with the representations,

complaints and appeals made against the decisions of competent authorities established under the EPA, granting environmental clearance under the EIA notification. NEAA is also expected to avoid delays arising out of protracted litigation involving development projects and effected people.

The MoEF has identified a total 25 centres located throughout the country as part of environmental information system (ENVIS) network and centres are responsible for collection, collation, storage, retrieval and dissemination of information on various subject specific areas of environment. All Centres are actively involved in strengthening the environmental database and responding to national and international queries relating to their specific subject areas. The MoEF has also set up seven Centre of Excellence to carryout research, training and awareness programme in priority areas of environmental science and management.

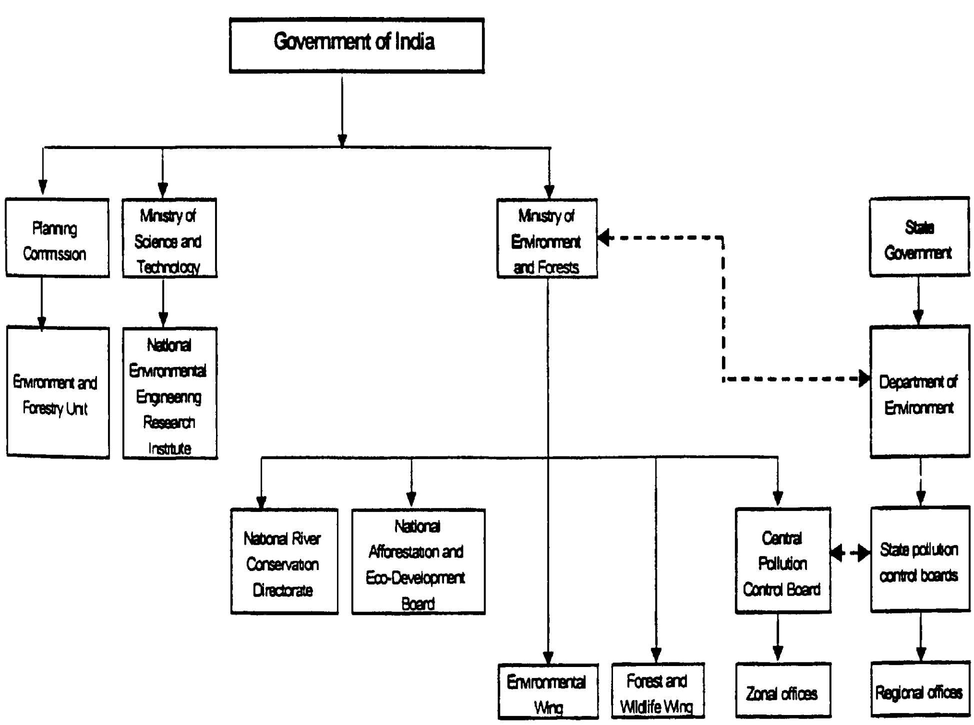


Figure 1 Organisational structure for protection and management of environment

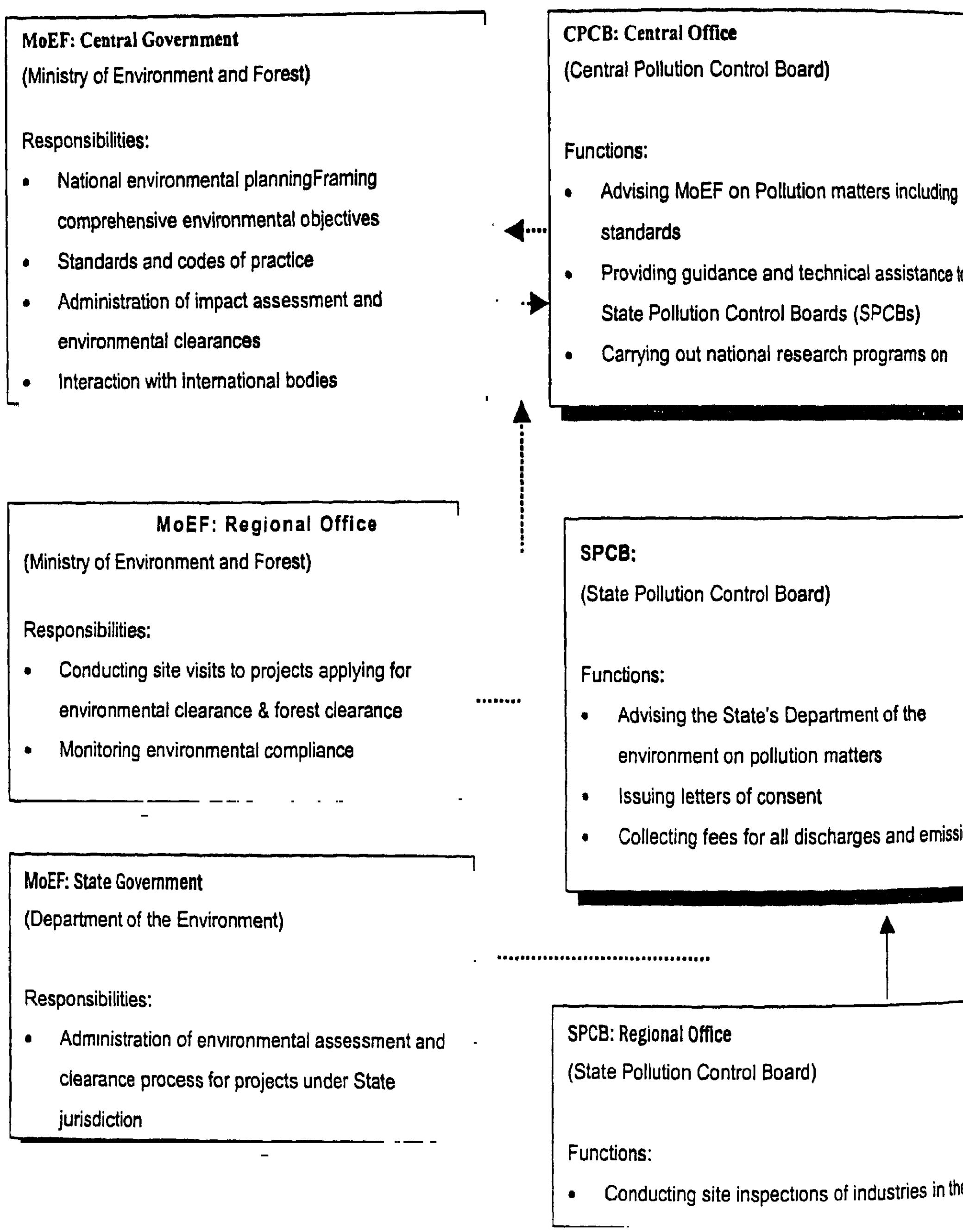


Figure 2. Institutional Arrangements and Information Flows on Environmental Issues

Environmental Standards

The risks posed to human health by air pollution have been evaluated since the 1950s and guideline values were derived in 1958. In 1987, the WHO Regional Office for Europe published the Air Quality Guidelines for Europe. Since 1993, these guidelines have been revised and updated. In a recent Expert Task Force Meeting convened in December 1997 in Geneva, Switzerland, the Guidelines for Air Quality was extended to provide global coverage and applicability, and the issues of air quality assessment and control were addressed in more detail. The air quality guidelines for major pollutants set by WHO are given in the Table 1.

The WHO Guidelines for Air Quality values are levels of air pollution below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short-term it does not mean that adverse effects automatically occur; however the risk of such effects increases. Although the Guidelines for Air Quality values are health - or environment-based levels, they are not standards per se. Air quality standards are air quality guidelines promulgated by governments, for which additional factors may be considered. For example, the prevailing exposure levels, the natural background contamination, environmental conditions such as temperature, humidity and altitude, and socio-economic factors.

When proceeding from the Guidelines for Air Quality to standards, policy options include such questions as what proportion of the general population, and which susceptible groups, should be protected. Several additional items must also be considered: the legal aspects; a definition of what constitutes adverse effects; a description of the population at risk; the exposure-response relationship; the characterization of exposure; an assessment of risks and their acceptability; and the financial costs of air pollution controls and their benefits. Faced with the growing problems of air pollution, a number of countries have established ambient air quality standards to protect the environment. India too, under Section 16(2)(h) of the Air (Prevention and Control of Pollution) Act, 1981, has enforced ambient air quality standards. Till early 1994, these were based on an eight-hourly averaging time only. In April 1994, these standards were revised to 24-hourly standards. The NAAQS (national ambient air quality standards) are prescribed for three distinct areas: (1) industrial; (2) residential, rural, and other; and (3) sensitive. In a notification brought out in November 1998, the standards for ammonia have been added to the national ambient air quality monitoring standards (Table 2).

I. Noise Standards

Of late, noise has been recognized as a pollutant, which, until recently, was considered only as a nuisance. The CPCB has notified the ambient noise standards in 1987 under Section 20 of the Air (Prevention and Control of Pollution) Act, 1981. In terms of additions to the standards as specified in Table 3, noise standards for 15–500 kVA generator sets / stationary diesel generator sets have been notified as lying between 85 and 90 dB (A). Studies of noise levels conducted in a few major cities seem to indicate that these levels are barely within limits in industrial zones but due to vehicular noise, the pollution limits in residential, silence, and commercial zones are being increasingly challenged everyday (MoEF 1999).

II. Water quality standards

Drinking water standards for India were set up by the ICMR (Indian Council of Medical Research). These are almost similar to the WHO (World Health Organization) drinking water standards. The USPHS (United States Public Health Service) has even more stringent standards.

For industries, surface water is the main source for drawing water for industrial purposes and discharging effluents. The water quality in surface water bodies depends on discharges at various stretches. Based on water quality criteria, the CPCB has designated water uses for all Indian rivers. This is done through classification of surface water into five categories, namely A, B, C, D, and E in decreasing order of quality (Table 4).

Discharges of industrial effluents are regulated through Indian Standards Codes – IS: 2490 (1974) for discharges into inland surface waters, IS: 3306 (1974) for discharges into public sewers, and IS:3307 (1974) for discharges on land for irrigation (Refer to Table 5 for general effluent discharge standards).Recently, water quality standards for coastal waters' marine outfalls have been specified.

Emission/Effluent standards for Industries

Industries consume energy mostly in the form of fuel for combustion and for feed material in a few cases. Air-borne emissions from various industries are a cause for major concern. These emissions are of two forms: (1) particulate emissions such as SPM (suspended particulate matter), and (2) gaseous emissions such as sulphur dioxide, oxides of nitrogen, and carbon monoxide. Liquid effluents, generated from certain industries, containing organic and toxic pollutants, are also a cause for serious concern. Heavily polluting industries

have been identified and are included under the 17 categories of highly polluting industries for the purpose of monitoring and regulating pollution.

The CPCB has, over the past two decades, developed standards for regulating emissions from various industries, and set emission standards for all polluting industries including thermal power stations. Among the most recent additions are the standards for gas-/naphtha-based thermal power plants (Tables 6). Industry-specific standards are also specified for iron and steel plants, cement plants, etc. (Tables 7–14). Most of the air quality emission standards include permissible limits for SPM and in a few cases sulphur dioxide, where it is the prime pollutant, while no standards for oxides of nitrogen and carbon monoxide are specified. The health risks of radioactive exposures can be fatal as has been recorded in the past.

As a result of rapid industrialization, many rivers in India are being polluted due to the discharge of effluents containing chemicals, pesticides and heavy metals. The standards laid down by CPCB for various Industries are given in Table 15-19.

Emission standards for vehicles

The share of vehicular pollution in urban areas is reaching alarming proportions (emission factors for different vehicles are given in Table 20). Vehicular emission control is also increasingly gaining attention. In India the first emission regulation for idle emissions became operational in 1989 and the first mass emission standard (CO & HC) in 1991 when emission standards were made applicable for automobiles produced in India. Initial emission norms in India have been very mild and stricter norms came into effect only from 1996. The history of emission regulation in India is given below.

1989 – Idle emission regulation
1991 – Mass emission regulation (CO & HC) (Hot start Indian driving circle)
1995 – Fitment of catalytic converters for cars in four metros
1996 – Tightening of emission limits (CO, HC & NOx), evaporative emission and crank case emission regulation
1997 – Catalytic norms for metros (50% of non-metro)
1998 – From September, fitment of catconverters in 42 major cities for petrol driven passenger cars
1999 – Emission norms fixed equivalent to Euro 1 norms for the NCR region with effect from June 1999 from Supreme Court

2000 – Further tightening of emission limits in line with EEC for four-wheelers in the NCR region by Supreme Court, tightest norms in the world for two-wheelers

2005 – Work in progress

The prevailing standards for petrol-driven vehicles for carbon monoxide are 3% for two- and three-wheelers and 4.5% for four-wheelers (Table 21). The standards for diesel-driven vehicles specify limits for smoke as 65 Hartridge units (Table 22).

These are emission standards with reference to volume of air. They do not constitute mass emission norms, the first stage of which came out in 1991 for petrol vehicles and in 1992 for diesel vehicles. The next stage of mass emission norms, Euro I, is to be initiated from 2000. And compliance with the next stage, Euro II norms, is to be initiated in 2005. On 29 April 1999, the Supreme Court brought forward the introduction of both stages of emission norms by ordering a move to disallow registration of all private non-commercial vehicles in the NCR (National Capital Region) failing to conform to Euro II fuel emission norms from 1 April 2000. The order forces automobile manufacturing companies to meet Euro I norms by 1 June 1999 and Euro II norms by 2000. Tables 23 and 24 compare standards specified at all of the above stages.

To conform to the Euro I and II norms, the quality of petrol and diesel has to adhere to specific fuel properties. These must include, initially, reduction or substitution of lead in petrol and reduction of sulphur in petrol and diesel. Also essential would be a complete or near-complete elimination of sulphur, aromatics, and heavy oils in diesel, and lead in petrol by using an oxygenated supplement like methyl tertiary butyl ether. However, there are no references to fuel quality in the Supreme Court order although fuel specifications are as integral to the shift to Euro norms as the technology used by the car manufacturers. Also, they hold particular importance for India at present as the existing Bureau of Indian Standards' specifications for petrol and diesel quality do not enable emissions that are up to the Euro standards – neither Euro I nor Euro II. They were set before Euro norms came into prominence in India (Bose 1999).

The early enforcement of the Euro norms has been preceded by a number of measures being introduced in the NCR recently. For instance, the Supreme Court has also taken measures such as restricting the plying of commercial vehicles like trucks in the daytime. Other measures pertain to the introduction o

unleaded petrol, which has now been made available in 42 major cities. By 2000, it will be made available throughout the country. As of now, low-lead petrol with a maximum lead content of 0.15 g/litre has been introduced throughout the country. Low-sulphur diesel, with a sulphur content of 0.5% or less, has been introduced in the four metros of Delhi, Mumbai, Calcutta, and Chennai from 1996. In Delhi and the Taj Trapezium area, the sulphur content in fuel has been further reduced. Compressed natural gas has been introduced for some categories of commercial vehicles.

The MoST (Ministry of Surface Transport) stipulated, in a notification brought out in 1998, that all four-wheeled petrol-driven vehicles registered after August 1998 in specified cities were to be fitted with catalytic converters. Emission norms for passenger cars fitted with catalytic converters were to be 50% lower than for cars without them.

Like some of the Asian countries, the population of two and three wheelers in India is the highest needing a further stringent control on these type of vehicles. Two-stroke engine vehicles are among the most polluting categories of vehicles. In 1998, the standards of the respective oils were specified, to be effective from April 1999. Also, pre-mixed fuel (petrol and oil) is being made available at petrol stations. Expansion of the availability of pre-mixed oil dispensers (petrol and 2T oil) shall be undertaken along with a ban on the supply of loose 2T oils at petrol stations and service garages.

One of the most significant lacunae in rules for controlling vehicular emissions was that they did not give sufficient consideration to older vehicles plying on the roads, with highly polluting technology. This issue being given its due importance with the government bodies and the Supreme Court coming down hard with a programme of phasing them out.

Ambient air quality

In India, most of the air pollution is restricted to urban areas where automobiles are the major contributors and to few other areas with a concentration of industries and thermal power plants. The major sources of air pollution in the country are industries (toxic gases), thermal power plants (flyash and SO_2), motor vehicles (CO, Pb and particulate matter) and by the burning of other fuels. Major polluting industries and automobiles emit tonnes of pollutants every day thereby putting citizens to great health risk. The major air pollutants are Particulate matter, sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbons (HC), Photochemical oxidants [ozone (O_3), peroxyacetyl nitrate

(PAN), peroxybenzoyl nitrate (PBN)], metals (Hg, Pb, Be, Cd, Zn) and other gases and vapours (H_2S, NH_3, etc)

Under the National Ambient Air Quality Monitoring (NAAQM) network, three criteria air pollutants, namely, SO_2, NO_2 and SPM have been identified for regular monitoring at all the 290 stations spread across the country. In ten metro cities, additional parameters such as respirable particulate matter, lead, hydrogen sulphide, ammonia and Polycyclic Aromatic Hydrocarbons (PAHs) are monitored as well. However, the NAAQM series publications of CPCB report only the three criteria pollutants (SO_2, NO_2 and SPM) and the latest published results for the year 1997 are given in the table 2.1.

CPCB analyzed the air quality of different cities/towns is presented in four broad categories based on an exceedance factor (EF), which is defined as the ratio of the observed annual mean concentration of a pollutant to the annual standard for the respective pollutant and area class. The summary of the analysis is shown in the table 2.2. The four air quality categories are Critical pollution (C) when EF is more than 1.5; High Pollution (H) when EF is between 1.0-1.5; Moderate pollution (M) with EF between 0.5 and 1.0; and Low Pollution (L) with EF less than 0.5 (CPCB 1999a). It is clear that locations in the categories C and H are violating the standards. For a city having more than one monitoring location in a given area class, the location with the highest concentration is considered.

The annual mean concentration of SO_2 violates the respective area standard at Nagda (M.P.) and Howrah (West Bengal), besides the sensitive location at Kota (Rajasthan). Likewise, in case of NO_2, the violations are observed at Alwar (Rajasthan), Howrah (West Bengal) and Visakhapatnam (Andhra Pradesh). In case of SPM, the ambient air quality standards for the different area categories are violated at 2 sensitive, 6 industrial and 44 residential locations (CPCB 1999a). The critical levels of SPM were observed in almost all the cities of Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, West Bengal, Delhi, and Union Territory of Pondicherry (CPCB 1999b).

The annual mean concentration of SPM exceeded the industrial standards at 6 locations in the state of Bihar (1), Delhi (1), Rajasthan (1), U. P. (2), and Pondicherry (1). Likewise, violations in case of SPM were observed at 44 residential areas spread over the states of Andhra Pradesh (3), Bihar (3), Chandigarh (1), Delhi (4), Himachal Pradesh (1), Karnataka (1), Maharashtra (5), Madhya Pradesh (7), Orissa (1), Punjab (3), Rajasthan (5), Uttar Pradesh (8), West Bengal (1), and Pondicherry (1). The stations located at Taj Mahal

(Agra, U.P.) and Barkhera (Kota, Rajasthan) exceeded the annual SPM standard for sensitive areas (CPCB 1999a).

The number of monitoring stations violating annual standards and 24-hourly standards for more than 2% of the times in the year 1997 with respect to individual criteria pollutant are shown in Table 2.3. It clearly indicates that high level of SPM is the most prevalent form of air pollution. At the same time, there do exist many stations where SO_2 and NO_2 levels are also exceeded.

In addition, the salient results of the monitoring of additional parameters at some of the stations in the metropolitan cities of Delhi, Calcutta, Mumbai & Chennai for the years 1996-97 are as follows (CPCB 1998):

- The annual mean concentration of respirable particulate matter (RPM) is much higher than the prescribed limits of 120 $\mu g/m^3$ (industrial) and 60 $\mu g/m^3$ (residential and other uses) in Delhi and Calcutta. However, RPM in Mumbai and Chennai is not very high but is more than the prescribed ambient air quality standards
- Though particulate lead in ambient air of Calcutta and Delhi is higher as compared to the other two cities (Chennai and Mumbai), it is well within the prescribed limits for the different area classes
- The concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) are showing an increasing trend. However, presently permissible limits for PAHs are not yet notified.

Noise pollution

Noise pollution is a direct manifestation of increasing industrialization, urbanization, vehicular traffic and other commercial activities. It is as much an environmental issue as water, air and soil pollution. Sound levels have increased over the time to the extent that it seems to be irreversible. The Central Pollution Control Board has been regularly conducting noise pollution surveys in major Indian cities. The average noise levels in dB(A) recorded in various metropolitan cities for the year 1995 is given in the table 2.4. The data indicates that the noise level exceeds the standard. A high level Committee on Noise Pollution has been constituted at the National Level to look into the growing menace of noise pollution in the major metropolitan cities of the country. The committee has recommended that noise levels from the bursting crackers should not exceed 100 dBA at the distance of four meters. Accordingly, directions have been issued to all the concerned authorities at the state level to check the noise pollution from bursting of crackers.

River water quality

Water is polluted by four kinds of substances: traditional organic waste, waste generated from industrial processes, chemical agents for fertilizers and pesticides for crop protection, and silt from degraded catchments. It is estimated that municipal sources are the main source of water pollution. Central Pollution Control Board (CPCB) in collaboration with State Pollution Control Board (SPCB) is monitoring the river water quality. The water quality monitoring results indicate that organic and bacterial pollution are the pre-dominant pollution in Indian rivers. The water borne diseases are the main cause of health problems in India. The pollution problems in small towns are basically associated with water. A survey of 241 class II towns in 17 states in India undertaken by CPCB indicates that, on average 90% of the water supplied is polluted.

For Industries, surface water is the main source for drawing water for industrial purposes and discharging effluents. The water quality in surface water bodies depends on discharges of effluents at various stretches. Based on water quality criteria, the CPCB has designated water uses for all Indian rivers. This is done through classification of surface water into five categories, namely, A, B, C, D, and E in decreasing order of quality (Table 2.5).

Pollution control programme in 17 categories of industries

Polluting industries

Central Pollution Control Board (CPCB) conducted a survey of industries in 1991. For large and medium sized industries, seventeen categories of industries have been identified as significantly polluting in terms of both air and water pollution. The list includes highly air polluting industries such as integrated iron and steel, thermal power plants, copper/zinc/aluminium smelters, cement, oil refineries, petrochemicals, pesticides and fertilizer units. Based on the information provided by State Pollution Control Board (SPCBs) / UT-Administrations, a total of 1551 large & medium units have been identified in the country under the 17 highly polluting industrial sectors. The State-wise distribution of the industries are given in Table 2.6. The table indicates that States of Maharashtra, Uttar Pradesh, Gujarat, Andhra Pradesh and Tamil Nadu have substantially large number of industries in the identified sectors. As shown in Table 2.7 the category-wise distribution of these 1,551 units reveals that sugar sector has the maximum number of (i.e. 392) industries, followed by pharmaceuticals, distillery, cement and fertilizer. It also indicates that agro-

based and chemical industries have major shares of 47% and 37% of the total number of industries respectively. About 77% and 15% of the industries are predominantly water polluting and air polluting respectively and 8% of the industries are potentially both air and water polluting.

Pollution Control Status in the 17 categories of Industries

As per the latest data collected by the CPCB, out of 1551, large and medium scale industries in 17 highly polluting categories, 1320 industries have installed the requisite pollution control facilities for complying with the stipulated emission norms and 164 industries have been closed down and 67 were identified as a defaulters. The defaulting units have been subjected to legal action by the CPCB under section 5 of the Environment Protection Act. The CPCB and SPCB are closely monitoring the status of pollution control in these industries. Maharashtra, Bihar, Orissa and West Bengal have the highest number of defaulting industries. Andhra Pradesh Maharashtra and Uttar Pradesh have maximum of closed units. On the other hand, Tamil Nadu and Gujarat have the largest number of industries having installed the requisite facilities. The state wise profile of status of polluting industries is given in Table 2.9. Figure 1 shows the state wise industries and industries having adequate facilities to comply the environmental standards.

Category wise summary status of the pollution control in 17 categories of industries (as per information available with CPCB as on March 31, 2000) is given in the table 2.10. The table indicates that all refineries, Zinc and Caustic soda industries have the adequate facilities to comply with the standards.

Bio-medical wastes

It is ironical that hospitals, nursing homes and clinics that provide relief to the ailing also create health hazards through indiscriminate disposal of bio-medical wastes. These include a variety of wastes such as hypodermic needles, scalpel blades, surgical gloves, cotton, bandages, clothes, medicines, blood and body fluid, human tissues and organs, body parts, radio active substances and chemicals. Some of these contain harmful organisms and disease causing agents. For instance, reuse of discarded syringes/needles with out disinfection can transmit leathel diseases, like AIDS and hepatitis. Similarly indiscriminate recycling of used cotton, clothes and medicines can pose a host of health hazards. Also improper incineration of wastes, particularly chlorinated organic compounds can result in noxious emissions including dreaded dioxin. The major

categories of bio medical wastes and its recommended disposal methods are given in the table 2.11.

Assuming a waste generation factor of 250 g/bed/day for infectious biomedical waste, Directorate General of Health Services has estimated total infectious biomedical waste generated from different states of India at 54,404 tonnes per annum as on 1 January 1993 (CPCB 2000b). WHO study on health care waste has estimated that of the total waste generated from health care facilities, about 85% of the waste is non-infectious, 10% infectious but non-hazardous and 5% hazardous (CPCB 2000b). Based on these estimates, the total health care waste generated as per 1993 data in the country can be taken as 544,040 tonnes per annum and hazardous waste generation from health care facilities can be taken as 27,202 tonnes per annum.

Industrial and Hazardous Waste

Hazardous waste can be generated by various industrial and non-industrial operations. Sources of hazardous waste include those from industrial processes, mining extraction, tailings from pesticide based agricultural practices, etc. Industrial operations lead to considerable generation of hazardous waste and in case of rapidly industrialising country such as India the contribution to hazardous waste from industries is largest. Hazardous waste generation from industries is also critical due to larger geographical spread of industrial units in the country, thereby leading to region wide impacts. The annual growth in hazardous waste generation can be directly linked to industrial growth in the country.

The States like Gujarat, Maharashtra, Tamil Nadu and Andhra Pradesh, which are relatively more industrialised and have undergone more industrial expansion, face the problem of toxic and hazardous waste disposal far more acutely than less developed states. Major hazardous waste generating industries in India include petrochemical, pharmaceutical, pesticide, paint and dye, petroleum, fertiliser, asbestos, caustic soda, inorganic chemicals and general engineering industries.

During the last 30 years, the industrial sector in India has quadrupled in size. The main source of hazardous waste generation and impact on the environment is the Indian chemical industry. There has been significant increase in industrial sectors such as pesticides, drugs and pharmaceuticals, textiles, dyes, fertilisers, tanneries, paint, chlor-alkali, etc. which have a major potential for generation of hazardous waste. Hazardous wastes from these industrial sectors contain heavy metals, cyanides, pesticides, complex aromatic compounds (such as PCBs), and other chemicals which are toxic, flammable, reactive, corrosive or have explosive properties.

The first few attempts to quantify hazardous waste generation in the country remain limited to indirect estimations. As per the correlation between the economic activity and hazardous waste generation established by Organisation for Economic Cooperation and Development (OECD), the reported generation of hazardous waste was about 0.3 million tonnes per annum in 1984. The World Bank estimates place this at approximately 4 million tonnes annually for the year 1995. The exercise to inventorise hazardous waste generation in different states of India was initiated by Central Pollution Control Board (CPCB) in the year 1993. Since then respective State Pollution Control Boards (SPCBs) are in process of preparing inventories of hazardous waste in their states. Most of this effort, however, remains limited to data collection through questionnaire mailed to industries. This is largely due to inability of SPCBs, due to lack of infrastructure and supporting staff, to visit the industries, collect samples and perform characterisation. Present information on total hazardous waste generated from industries and facility available for their disposal in the respective states in India has been collected by the Ministry of Environment and Forests (MoEF) through respective SPCBs. Table 2.12 gives state-wise status of number of units generating hazardous waste as well as quantity of waste generated till 24 March 2000 for waste types like recyclable, incinerable and disposable.

In total, at present around 7.2 million tonnes of hazardous waste is generated in the country of which 1.4 million metric tonnes is recyclable, 0.1 million metric tonnes is incinerable and 5.2 million metric tonnes are destined for disposal on land (MoEF 2000).

The major generators of non-hazardous industrial solid wastes (high volume – low hazard wastes) in India are thermal power stations producing coal ash, steel mills producing blast furnace slag and steel melting slag, non-ferrous industries like aluminium, zinc and copper producing red mud and tailings, sugar industries generating press mud, pulp and paper industries producing lime sludge and fertiliser and allied industries producing gypsum. The quantities of industrial waste produced per annum from these industrial and mining sources are presented in Table 2.13 and Table 2.14.

There are at present 116 hazardous waste incinerators in the country and 11 engineered landfills in operation and all of them are located in Gujarat. In addition, 74 sites have been identified in various states to set up disposal facilities of which 14 sites have been notified.

Municipal Solid Waste (MSW)

The daily per capita generation of MSW in India ranges from about 100 g in small towns to 500 g in large towns. The recyclable content of waste ranges from

13% to 20% (CPCB 1994/95). A primary survey in 1971 estimated that the urban population generated 374 g/capita/day of solid waste (Bhide and Sundersan 1983). In another survey conducted by NEERI the quantity of waste produced has been found to vary from 200 to 600 g/capita/day. A survey in 1981 places this figure at 432 g/capita/day (Nath 1984) and yet another survey in 1995 at 456 g/capita/day (EPTRI 1995). A survey conducted by ORG in 1989 places total MSW generation for 33 Indian cities at 14,934 tonnes a day. The EPTRI estimates of the survey in 1995 for 23 Indian cities places it around 11 million tonnes a year. The survey conducted by CPCB puts total municipal waste generation from class I and II cities to around 18 million tonnes in 1997 (CPCB 2000). The present annual solid waste generated in Indian cities has increased from 6 million tonnes in 1947 to 48 million tonnes in 1997 and expected to increase to 300 million tonnes per annum by 2047 (CPCB 2000).

The characteristics of MSW collected from any area depends on a number of factors such as food habits, cultural traditions of inhabitants, lifestyles, climate, etc. The per capita municipal solid waste generation in various cities are given in Table 2.15. Table 2.16 presents the changes in the characteristics of waste in past two decades. The data show that changes in the relative shares of different constituents of waste in the past several decades can be largely attributed to the changing lifestyles and increasing consumerism.

Only few cities follow good practice of waste disposal as tipping of waste using mechanised equipment for levelling and compacting the waste and placing a daily cover of soil layer on top of it before compacting it further. Some of the municipalities are also practising composting of organic fraction of the waste (Table 2.17). However, overall, the average waste collection efficiency of the total generation in Indian cities is around 72% (NIUA 1989) and 70% of the Indian cities do not have adequate waste transportation facilities.

Market potential for Municipal Solid Waste Treatment in India

As per the recent estimates done by Ministry of Non conventional Energy Sources (MNES), the total Indian market for municipal solid waste treatment and disposal technologies (excluding collection and transportation) in 1997 is about US$ 270 million. The market is projected to grow at an average annual growth rate of 20 percent during the next three years. Composting technology, due to its simplicity and low capital requirement accounts for almost 50% of the market. The breakdown of the market in terms of technologies for municipal solid waste treatment and disposal is given in table 2.18. The major technology categories with their existing share in the market and their rank in terms of sales

prospects over the next 3 years are presented in the table 2.19. There are few domestic companies, namely Zen Global Finance limited, Enkem Engineers Ltd, Future Fuels Engg (India) pvt. Ltd, Global Environmental Engineering limited, Thermax Ltd EDL Power (India) ltd and Excel Industries Ltd are providing technology and equipment and services for the Indian market for municipal sold waste treatment and disposal. Major financial institutions such as the Industrial Finance Corporation of India (IFCI), Small Industrial Development Bank of India (SIDBI), Industrial Credit and Investment Corporation of India (ICICI) and Industrial Development Bank of India (IDBI) are providing attractive financial packages for projects in the MSW treatment, disposal and management field. The multilateral and bilateral donor agencies also assist in funding such projects. IREDA administers revolving funds to promote, develop and finance waste-to-energy projects. HUDCO also offers attractive financing schemes as a part of their waste management promotion measure. There is no restriction on use of hard currency for equipment purchases.

Coal

Table 1.01 Coal resources of states (million tonnes): 1 January 2000

State	*Proved*	*Indicated*	*Inferred*	*Total*
Andhra Pradesh	7,346	3,312	2,929	13,587
Arunachal Pradesh	31	11	48	90
Assam	259	27	34	320
Bihar	34,794	28,692	5,642	69,128
Madhya Pradesh	13,010	22,148	8,334	43,493
Maharashtra	4,149	1,323	1,605	7,077
Meghalaya	118	41	301	459
Nagaland	3	1	15	20
Orissa	11,140	22,755	16,554	50,449
Uttar Pradesh	766	296	0	1,062
West Bengal	10,779	10,894	4,236	25,909
Total	82,396	89,501	39,697	211,594

Source

MoC. 2000. ***Annual Report 1999/2000*** New Delhi: Ministry of Coal.

Table 1.02 Coal reserves by category (million tonnes): 1 January 2000

Types of coal	*Proved*	*Indicated*	*Inferred*	*Total*
Coking				
Prime coking	4,614	699	–	5,313
Medium coking	11,267	11,133	1,106	23,506
Blendable/semi-coking	482	904	222	1,608
Sub-total	16,364	12,735	1,328	30,427
Non-coking*	66,032	76,765	38,369	181,167
Total (Coking and non-coking)	82,396	89,501	39,697	211,594

* including coals of the north-eastern region

Source

MoC. 2000. ***Annual Report 1999/2000***. New Delhi: Ministry of Coal.

Table 1.03 Lignite reserves of states and union territories (**million tonnes**): 1998/99

State / Union Territory	*Geological reserves*
Tamil Nadu and Pondicherry	
Neyveli	3,300
Bahur	575
Jayamkondacholapuram	1,167
Mannargudi	19,500
East of Veeranam	1,422
Kudikadu	133
Micheal Patti	23
Meensuruti	458
Kulanchavadi	175
Rajasthan	1,828
Gujarat	1,505
Jammu and Kashmir	128
Kerala	108
Total	30,322

Source

MoC. 2000. ***Annual Report 1999/2000***. New Delhi: Ministry of Coal.

Table 1.04 All-India production of coal, lignite, and other derivatives (million tonnes): 1975/76 to 1999/2000

Items	*1975/76*	*1980/81*	*1985/96*	*1990/91*	*1991/92*	*1992/93*	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*1997/98*	*1998/99*	*1999/00*
Coking coal	27.4	31.7	35.2	44.9	45.80	45.21	44.66	41.97	39.91	40.50	43.80	39.2	33.0
Non-coking coal	72.3	82.3	119.1	169.0	187.00	196.80	204.02	215.80	233.50	245.50	253.33	253.1	267.1
Total coal [a]	99.7	114.0	154.3	213.9	232.80	242.00	248.68	257.77	273.42	286.10	297.20	292.3	300.1
Lignite	3.0	5.1	8.0	14.1	15.99	16.62	18.10	19.31	22.15	22.60	23.10	23.4	22.1
Total coal and lignite	102.7	119.1	162.3	225.7	245.40	255.11	266.78	277.08	295.56	308.70	320.20	315.7	322.2
Soft coke	2.7	2.3	1.7	0.9	0.73	0.48	0.43	0.25	0.17	0.10	–	–	–
Beehive hard coke	0.8	0.6	0.3	0.1	0.17	0.13	0.12	0.08	0.06	0.10	0.10	–	–
By-product hard coke	0.6	0.4	0.3	10.2	10.48	10.60	10.58	10.93	10.86	11.00	10.60	10.8	11.4
Washed coal	11.4	11.6	10.9	11.2	12.50	12.80	12.14	11.75	11.92	10.90	10.00	9.7	9.1
Middlings	3.9	4.3	5.1	5.6	6.07	6.46	6.64	6.30	6.80	6.80	7.60	7.2	6.2
Total exports	0.4	0.1	0.2	0.1	0.11	[illegible]	0.10	0.12	0.09	0.10	0.10	–	–
Total imports	–	0.6	2.0	4.9	5.92	[illegible]	7.10	8.30	8.90	9.50	9.50	–	–

[a] includes Meghalaya figures for the unorganized sector

Source
CCO. ***Coal Directory of India*** (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.05 Coal production of various states (million tonnes): 1975/76 to 1999/2000

Year	*Andhra Pradesh*	*Assam*	*Bihar*	*Madhya Pradesh*	*Maharashtra*	*Orissa*	*Uttar Pradesh*	*Bengal*	*Meghalaya*	*All-India*
1975/76	7.4	0 6	41 8	20 4	3.7	2 2	–	23.7	–	99 8
1980/81	10.1	0.6	46.6	25.9	5.8	3.2	1.8	20.0	–	114 0
1985/86	15.7	0 9	54.3	42.6	11.6	6.0	3.9	19.4	–	154.4
1990/91	17.7	0.7	67.3	65.2	16.9	16.2	10.5	17.2	2.2	213.9
1991/92	20.6	1.0	69.0	69 4	18.9	20.7	11.5	18.2	3.5	232.8
1992/93	22.5	1.1	71.1	70 7	19.7	23.1	12.2	18.1	3.5	242.0
1993/94	25.3	1.2 [a]	73.3	72 9	20.5	24.3	12.1	16.6	2.5	248.7
1994/95	25.7	1.2 [a]	73.3	74.9	21.1	27.3	13.8	17.2	3.3	257.8
1995/96	25.0	0.8	74.6	79 8	22.8	32.7	14.8	17.9	3 3 [b]	273.5
1996/97	28.7	0.8	77.7	83.3	24.9	37.4	15.4	18.0	–	286.1
1997/98	28.9	0.7	81.3	84.8	26.2	42.2	15.8	17.4	–	297.2
1998/99	27.3	0.6	76.2	84.9	25.3	43.5	15.6	18.8	–	292.3
1999/00	29.6	0.6	76.9	87.9	27.7	43.6	16.2	17.6	–	300.1

[a] includes Arunachal Pradesh and Meghalaya under the north-eastern coalfields

[b] figures for the unorganized sector

Source

CCO. ***Coal Directory of India*** (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.06 Coal despatches of various states (million tonnes): 1975/76 to 1999/2000

Year	*Andhra Pradesh*	*Assam*	*Bihar*	*Madhya Pradesh*	*Maharashtra*	*Orissa*	*Uttar Pradesh*	*Bengal*	*Meghalaya*	*All-India*
1975/76	7.0	0.6	33.1	19.5	3.4	2.0	–	21.2	–	86.8
1980/81	10.1	0.1	39.1	24.6	5.7	2.8	1.6	17.3	–	101.3
1985/86	15.4	0.8	53.7	42.0	11.7	5.3	3.6	18.5	–	151.0
1990/91	24.6	0.9	60.8	62 8	17.4	16.0	10.2	15.7	2.2	210.6
1991/92	20.0	1.0	63.1	68.0	18.9	19.6	11.4	17.1	3.5	222.6
1992/93	21.7	0.9	69.4	69.7	19.1	21.9	11.6	16.3	3.5	234.1
1993/94	24.6	0.8 [a]	72.6	72.1	19.8	24.0	12.9	15.8	2.5	245.1
1994/95	24.0	0.8 [a]	73.2	73.1	21.2	26.9	13.7	16.2	3.3	252.4
1995/96	24.9	1 0 [a]	72.7	78.6	24.3	34.4	14.9	16.6	3.3 [b]	270.7
1996/97	28.8	0 8	76.0	83.7	24.7	37.2	15.7	16.7	–	283.7
1997/98	29.0	0.6	77.1	86.5	25.0	43.3	15.6	16.8	–	293.9
1998/99	26.7	0.7	75.5	83.8	24.3	41.8	14.8	17.2	–	284.7
1999/00	29.8	0.8	77.2	87.1	28.4	42.1	16.7	18.3	–	300.4

[a] includes Arunachal Pradesh and Meghalaya under the north-eastern coalfields

[b] figures for the unorganized sector

Source

CCO *Coal Directory of India* (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.07 **Coal pithead stock of various states (million tonnes): 1975/76 to 1999/2000**

Year	*Andhra Pradesh*	*Assam*	*Bihar*	*Madhya Pradesh*	*Maharashtra*	*Onssa*	*Uttar Pradesh*	*Bengal*	*Meghalaya*	*All-India*
1975/76	0.5	–	6.8	1.7	0.2	0.4	0.0	2.2	–	11.8
1980/81	0.5	–	11.1	3.3	0.2	0.5	0.1	2.7	–	18.4
1985/86	0.6	0.2	16.5	6.1	0.8	2.1	0.2	2.5	–	29.0
1990/91	0.7	0.3	24.7	7.8	2.4	3.1	0.7	2.9	–	42.6
1991/92	0.7	0.1	29.4	8 4	2.1	4.1	0.8	2.9	–	48.5
1992/93	0.9	0.4	29.2	8.7	2.6	4.6	1.5	3.5	–	51.4
1993/94	0.9	0.8	28.5	8.9	3.0	4.8	0.6	3.1	–	50.6
1994/95	2.1	1.2	22.4	10.0	2.7	5.2	0.8	3.2	–	47.6
1995/96	2.5	0.9	22.9	10.6	1.0	3.4	0.7	3.7	–	45.7
1996/97	1.9	0.8	20.8	9.5	1.1	3.5	0.4	4.1	–	42.0
1997/98	1.4	0.9	23.4	7.1	2.0	2.3	0.4	3.9	–	41.5
1998/99	1.7	0.8	18.1	7.8	2.8	4.0	1.3	3.7	–	40.1
1999/00	1.2	0.6	9.2	8 0	2.1	5.4	0.8	1.4	–	28.7

Source

CCO. ***Coal Directory of India*** (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.08 Coal production of various companies (million tonnes): 1993/94 to 1998/99

Company	4	5	6	7	8	9
Coal India Ltd						
Eastern Coalfields Ltd	22.61	24.85	27.80	29.65	27.44	27.16
Bharat Coking Coal Ltd	29.04	28.75	27.81	27.14	30.92	27.18
Central Coalfields Ltd	33.51	31.21	30.76	32.21	33.10	32.18
South Eastern Coalfields Ltd	47.53	50.00	53.17	55.30	56.63	57.56
Mahanadi Coalfields Ltd	24.29	27.33	32.70	37.37	42.16	43.51
Western Coalfields Ltd	26.50	27.24	29.01	31.23	32.51	31.74
Northern Coalfields Ltd	31.41	32.50	35.20	37.01	37.56	36.52
North Eastern Coalfields	1.20	1.19	0.82	0.75	0.69	0.64
Total	216.10	223.07	237.28	250.65	261.01	256.49
Singareni Collieries Company Ltd	25.28	25.65	26.77	28.73	28.94	27.33
Jammu and Kashmir Minerals Ltd	0.02	0.02	0.02	0.02	0.01	0.01
Damodar Valley Corporation	0.07	0.29	0.23	0.29	0.36	0.37
Bengal Emta Coal Mines Ltd	–	–	–	–	0.71	1.80
Bihar State Mineral Development Corporation	–	–	–	0.26	0.20	0.19
Indian Iron and Steel Company Ltd	0.72	1.04	0.99	0.86	0.72	0.84
Tata Iron and Steel Company Ltd	3.96	4.16	4.90	5.30	5.23	5.22

Source

CCO. ***Coal Directory of India*** (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.09 Coal despatches of various companies (million tonnes): 1993/94 to 1998/99

Company	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*1997/98*	*1998/99*
Coal India Ltd						
Eastern Coalfields Ltd	22.19	24.22	25.81	28.04	26.64	25.54
Bharat Coking Coal Ltd	28.54	28.34	26.55	26.75	27.57	26.83
Central Coalfields Ltd	33.02	31.18	30.84	31.19	32.49	31.98
South Eastern Coalfields Ltd	46.91	47.81	52.27	56.12	58.33	56.93
Mahanadi Coalfields Ltd	24.00	26.93	34.36	37.22	43.40	41.76
Western Coalfields Ltd	25.52	27.26	30.37	30.91	31.35	30.44
Northern Coalfields Ltd	32.37	32.92	35.07	37.09	37.47	35.46
North Eastern Coalfields	0.75	0.83	1.03	0.83	0.57	0.70
Total	213.30	219.49	236.29	248.15	257.82	249.63
Singareni Collieries Company Ltd	24.60	25.04	24.87	28.82	29.02	26.71
Jammu and Kashmir Minerals Ltd	0.02	0.02	0.02	0.02	0.01	0.01
Damodar Valley Corporation	0.07	0.27	0.23	0.29	0.36	0.33
Bengal Emta Coal Mines Ltd	–	–	–	–	0.69	1.78
Bihar State Mineral Development Corporation Lt	–	–	–	0.26	0.19	0.20
Indian Iron and Steel Company Ltd	0.68	1.03	1.00	0.87	0.73	0.81
Tata Iron and Steel Company Ltd	3.94	4.28	4.91	5.29	5.20	5.21

Source

CCO. ***Coal Directory of India*** (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.10 Coal pithead stock of various companies (million tonnes): 1993/94 to 1998/99

Company	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*1997/98*	*1998/99*
Coal India Ltd						
Eastern Coalfields Ltd	6.55	6.17	7.21	5.19	5.09	5.90
Bharat Coking Coal Ltd	13.29	8.02	8.56	8.26	10.95	4.76
Central Coalfields Ltd	11.51	11.13	10.57	11.21	11.03	10.91
South Eastern Coalfields Ltd	7.07	8.80	9.22	7.89	6.01	6.27
Mahanadi Coalfields Ltd	4.82	5.15	3.40	3.48	2.29	4.00
Western Coalfields Ltd	3.52	3.15	1.44	1.43	2.29	3.31
Northern Coalfields Ltd	1.91	1.49	1.61	1.62	1.27	2.29
North Eastern Coalfields	0.82	1.17	0.87	0.83	0.93	0.84
Total	49.48	45.07	42.87	39.9	39.84	38.24
Singareni Collieries Company Ltd	0.95	2.09	2.52	1.89	1.38	1.67
Jammu and Kashmir Minerals Ltd	0.01	0.01	–	–	–	–
Damodar Valley Corporation	–	0.02	–	–	–	0.04
Bengal Emta Coal Mines Ltd	–	–	–	–	0.02	0.03
Bihar State Mineral Development Corporation L	–	–	–	0.01	0.01	0.03
Indian Iron and Steel Company Ltd	0.27	0.23	0.21	0.18	0.17	0.03
Tata Iron and Steel Company Ltd	0.05	0.08	0.05	0.04	0.04	0.04

Source

CCO. *Coal Directory of India* (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

West Bengal												
Bharat Coking Coal Ltd	0.18	0.57	0.17	0.51	0.13	0.43	0.13	0.59	0.32	0.42	–	–
Eastern Coalfields Ltd	0.14	15.82	0.13	16.68	0.15	16.95	0.09	15.73	0.08	16.05	–	–
Indian Iron and Steel Company Ltd	0.02	0.51	0.01	0.42	0.03	0.30	0.05	0.16	0.01	0.29	–	–
Bengal Emta Coal Mines Ltd	–	–	–	–	–	–	–	0.71	–	1.79	–	–
Total	0.34	16.90	0.31	17.61	0.31	17.69	0.27	17.18	0.22	18.55	–	–
Bihar	22.30	5.69	21.55	5.58	21.27	5.31	24.19	6.01	21.57	5.06	–	–
Bharat Coking Coal Ltd	0.29	8.60	0.24	10.76	0.22	12.33	0.21	11.42	0.21	10.83	–	–
Eastern Coalfields Ltd	13.38	18.11	11.45	19.31	11.75	20.43	12.23	20.87	10.03	22.15	–	–
Central Coalfields Ltd	–	0.29	–	0.23	–	0.29	–	0.36	0.37	–	–	–
Bihar State Mineral DevelopmentCorporation Ltd	–	–	–	–	–	0.26	–	0.20	–	0.19	–	–
Indian Iron and Steel Company Ltd	0.51	–	0.56	–	0.52	–	0.51	–	0.53	0.01	–	–
Tata Iron and Steel Company Ltd	4.16	–	4.90	–	5.30	–	5.23	–	5.14	0.08	–	–
Total	40.64	32.69	38.69	35.87	39.05	38.63	42.36	38.85	37.84	38.32	–	–
Outlying fields												
Northern Coalfields Ltd	–	32.50	–	35.20	–	37.01	–	37.56	–	36.52	–	38.43
South Eastern Coalfields Ltd	0.13	49.87	0.16	53.01	0.48	54.83	0.47	56.16	0.46	57.10	–	–
Mahanadi Coalfields Ltd	–	27.33	–	32.70	–	37.37	–	42.16	–	43.51	–	43.55
Western Coalfields Ltd	0.86	26.39	0.75	28.25	0.70	30.52	0.74	31.78	0.65	31.08	–	–
North Eastern Coalfields	–	1.19	–	0.82	–	0.75	–	0.69	–	0.64	–	0.57
Singareni Collieries Company Ltd	–	25.65	–	26.77	–	28.73	–	28.94	–	27.33	–	27.56
Jammu and Kashmir Minerals Ltd	–	0.02	–	0.02	–	0.02	–	0.01	–	0.01	–	0.03
Total	–	162.95	0.91	176.78	1.18	189.23	1.21	197.30	1.11	196.19	–	–
Public												
Coal India Ltd	37.28	186.07	34.45	202.82	34.69	215.93	38.06	252.62	34.04	251.19	–	–
Singareni Collieries Company Ltd	–	25.65	–	26.77	–	28.73	–	28.94	–	27.33	–	27.56
Jammu and Kashmir Minerals Ltd	–	0.02	–	0.02	–	0.02	–	0.01	0.01	–	–	–
Damodar Valley Corporation	–	0.29	–	0.23	–	0.29	–	0.36	0.37	–	–	–
Bengal Emta Coal Mines Ltd	–	–	–	–	–	–	–	0.71	–	1.79	–	–
Bihar State Mineral Development Corporation Ltd	–	–	–	–	–	0.26	–	0.20	–	0.19	–	–
Indian Iron and Steel Company Ltd	0.53	0.51	0.57	0.42	0.55	0.30	0.56	0.16	0.53	0.01	–	–
Total	37.81	212.54	35.02	230.25	35.25	245.54	38.62	252.62	34.04	251.19	–	–
Private												
Tata Iron and Steel Company Ltd	4.16	–	4.90	–	5.30	–	5.23	0.71	5.14	0.08	–	–
All India	41.97	212.54	39.91	230.25	40.54	245.54	43.84	253.33	39.18	253.09	–	–

Source

CCO. 1999. ***Coal Directory of India 1998/99*** . Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.12 Import of coking and non-coking coal (million tonnes): 1991/92 to 1998/99

Year	*Coking coal*	*Non-coking coal*	*Total*
1991/92	5.27	0.66	5.93
1992/93	6.32	0.42	6.74
1993/94	6.82	0.57	7.39
1994/95	10.15	1.24	11.39
1995/96	9.37	3.14	12.51
1996/97	9.78	4.53	14.31
1997/98	10.65	6.56	17.21
1998/99[a]	9.64	6.00	15.64

[a] provisional

Source

MoC. 1999. ***Annual Report 1998/99***. New Delhi: Ministry of Coal.

Table 1.14 OMS (Output per man-shift) in opencast and underground mining (tonnes): 1975/76 to 1999/2000

Companies	*1975/76*	*1980/81*	*1985/86*	*1990/91*	*1991/92*	*1992/93*	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*1997/98*	[a]	*1999/00*[a]
Overall													
CIL (Coal India Ltd)	0.65	0.70	0.92	1.30	1.40	1.46	1.52	1.63	1.75	1.86	1.93	2.03	1.99
SCCL (Singareni Collieries Company Ltd	0.69	0.70	0 92	0.96	0.98	1.04	1.05	1.08	1.23	1.19	1.31	1 31	1 31
Opencast													
CIL	0.90	1.50	2.24	3.31	3.70	3.80	4.00	4.35	4.73	5.12	5.07	5.52	5 29
SCCL	0	0	3.54	4.74	4.48	4.46	4.38	3 63	3.66	2.96	3.50	3 92	4 00
Underground													
CIL	0.60	0.50	0.53	0.53	0.53	0.55	0.55	0.56	0.56	0.57	0.57	0.59	0 60
SCCL	–	–	0.87	0.65	0.67	0.70	0.71	0 69	0.74	0.72	0.76	0.75	0 73

[a] April-December

Note

The OMS of the SCCL is worked out on the CIL formula from 1987/88.

Source

MoC. 2000. ***Annual Report 1999/2000***. New Delhi: Ministry of Coal.

Table 1.15

Categorization of coal and coke

Class		
Non-coking coal produced in all states other than Assam, Arunachal Pradesh, Meghalaya, and Nagaland	A	UHV (Useful heat value) greater than 6200 kcal/kg
	B	UHV 5600 6200 kcal/kg
	C	UHV 4940 5600 kcal/kg
	D	UHV 4200 4940 kcal/kg
	E	UHV 3360 4200 kcal/kg
	F	UHV 2400 3360 kcal/kg
	G	UHV 1300 2400 kcal/kg
Non-coking coal produced in the states of Arunachal Pradesh, Assam, Meghalaya, and Nagaland	Not graded	
Coking coal		
Steel	I	Ash content not exceeding 15%
Steel	II	Ash content greater than 15% but less than 18%
Washery	I	Ash content greater than 18% but less than 21%
Washery	II	Ash content greater than 21% but less than 24%
Washery	III	Ash content greater than 24% but less than 28%
Washery	IV	Ash content greater than 28% but less than 35%
Semi-coking and weakly coking coals		
Semi-coking	I	Ash plus moisture content not exceeding 19%
Semi-coking	II	Ash plus moisture content greater than 19% but not exceeding 2
Long-flame coal produced in collieries in all the states excepting Assam, Arunachal Pradesh, Meghalaya, Nagaland, and the Singareni collieries in Andhra Pradesh	A	UHV greater than 6200 kcal/kg
	B	UHV greater than 5600 kcal/kg but not exceeding 6200 kcal/k
	C	UHV greater than 4940 kcal/kg but not exceeding 5600 kcal/k
	D	UHV greater than 4200 kcal/kg but not exceeding 4940 kcal/k
Hard coke		
By-product	Premium	Ash content not exceeding 25%
By-product	Ordinary	Ash content greater than 25% but not exceeding 30%
Beehive	Premium	Ash content not exceeding 27%
Beehive	Superior	Ash content greater than 27% but not exceeding 31%
Beehive	Ordinary	Ash content greater than 31% but not exceeding 36%

Notes

1 Coking coals have been classified thus by the erstwhile Coal Board under the Coal Mines (Conservation, Safety, and Development) Act, 1952 (12 of 1952) (since repealed) or such coals as have been declared or may be declared as coking coal by the central government under the Colliery Control Order, 1945, or the Coal Mines (Conservation and Development) Act, 1974 (28 of 1974), and the rules made under both the aforesaid Acts.

2 Semi-coking coals and weakly-coking coals are classified as 'blendable coals' by the erstwhile Coal Board under the Coal Mines (Conservation, Safety, and Development) Act, 1952 (12 of 1952) (since repealed), or as may be declared as 'semi-coking' or 'weakly coking' coals by the central government under the Colliery Control Order, 1945, or the Coal Mines (Conservation and Development) Act 1974 (28 of 1974), and the rules made under both the aforesaid Acts

3 Coals other than coking, semi-coking, or weakly-coking coals are non-coking coals

4 UHV is defined by the formula: UHV in kcal/kg = (8900 - 138 x [percentage of ash content + percentage of moisture content])
In the case of coal having moisture less than 2% and volatile content less than 19%, the UHV shall be the value arrived as above, reduced by 150 kcal/kg for each 1% reduction in volatile content below 19% fraction pro-rata Both moisture and ash shall be determined after equilibrating at 60% relative humidity and 40°C temperature as per relevant clauses of the Indian Standard Specification No IS:1350-1959

5 Ash percentage of coking coals and hard coke shall be determined after air-drying as per IS:1350-1959 If the moisture so determined is more than 2%, the determination shall be after equilibrating at 60% relative humidity at 40 °C as per IS.1350-1959.

6 Long-flame coals shall be defined by the parameters as laid down in Table II of the Indian Standard Specification No IS 770-1964, 'General classification of co (Revised)'. The volatile matter (on unit coal basis) present in these coals exceeds 32%

7 The above classification shall not apply to coals other than bituminous or sub-bituminous coals as specified under the Indian Standard Specification No. IS.77-1

Source

MoC. 1995. The Gazette of India, Extraordinary, Part II, Section 3, Sub-section (ii), No. 718. pp. 3-4. New Delhi: Ministry of Coal. 5 pp.

Table 1.16 Comparison of GCV (gross calorific value) and UHV (useful heat value) for non-coking coal (with six per cent moisture content)

	UHV (kcal/kg)		*Ash (%)*		*GCV (kcal/kg)*	
Grade	*From*	*To*	*From*	*To*	*From*	*To*
A	0	>6200	–	<13.56	–	>6406
B	5600	6200	13.56	17.91	5997	6406
C	4940	5600	17.91	22.69	5447	5997
D	4200	4940	22.69	28.06	5042	5447
E	3360	4200	28.06	34.14	4469	5042
F	2400	3360	34.14	41.1	3814	4469
G	1300	2400	41.1	49.07	3064	3814

Source

TERI. 1997. Relative economics of fuels in power generation. TERI Report. New Delhi: Tata Energy Research Institute.

Table 1.17 Production from coal washeries (**million tonnes**): 1975/76 to 1999/2000

Feed and production	*1990/91*	*1991/92*	*1992/93*	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*1997/98*	*1998/99*	*1999/00*
Prime coking coal										
Raw coal feed	12.47	12 57	12.05	12.95	13.30	13.09	12.8	–	–	–
Clean coal production	6.44	6.78	6.54	6.69	6.88	6.76	5.9	4.5	–	–
Middling production	3.08	3.47	3.48	3.70	3.52	4.00	3.7	–	–	–
Medium coking coal										
Raw coal feed	8.03	9.24	10.44	9.74	9.44	9.91	9.4	–	–	–
Clean coal production	4.73	5.16	5.56	5.43	4.87	5.10	5.0	5.4	–	–
Middling production	2.46	2.60	2.98	2.91	2.81	2.80	3.1	–	–	–
Total										
Raw coal feed	20.50	21.81	22.49	22.69	22.74	23.00	22.2	22.0	21.1	12.0
Clean coal production	11 10	12.00	12.10	12.12	11.75	11.90	10.9	10.0	9 7	5.6
Middling production	5.60	6.07	6.46	6.61	6.33	6.80	6.8	7.5	7.2	4.4

Sources

1 CCO *Coal Directory of India* (various issues) Calcutta: Coal Controller's Organization, Ministry of Coal.

2 MoC 1998 *Annual Report 1997/98* New Delhi: Ministry of Coal.

Table 1.18 Raw coal feed (million tonnes) and clean coal production (million tonnes) of washeries: 1993/94 to 1998/99

Company/	Raw coal feed						Clean coal production					
Washeries	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99
Bharat Coking Coal Ltd												
Dugda I	1.14	1.09	0.85	0.53	0.01	0.11	0.54	0.51	0.48	0.26	0	0.07
Dugda II	1.25	1.25	1.10	1.10	1.22	0.99	0.60	0.59	0.62	0.48	0.48	0.40
Bhojudih	1.51	1.61	1.49	1.45	1.49	1.50	0.98	1.01	0.98	0.86	0.83	0.80
Patherdih	0.93	1.01	1.02	0.98	0.81	0.73	0.52	0.62	0.65	0.55	0.34	0.27
Lodna	0.37	0.34	0.34	0.28	0.25	0.33	0.20	0.19	0.18	0.14	0.11	0.14
Sudamdih	0.85	1.02	0.94	0.90	0.84	0.88	0.34	0.47	0.42	0.39	0.33	0.32
Barora	0.32	0.33	0.32	0.34	0.36	0.32	0.12	0.13	0.15	0.14	0.14	0.11
Moonidih	1.05	1.07	0.99	0.98	1.03	0.92	0.51	0.55	0.50	0.49	0.51	0.44
Mohuda	0.36	0.34	0.35	0.37	0.37	0.35	0.26	0.24	0.24	0.24	0.25	0.22
Total	7.78	8.06	7.40	6.93	6.38	6.23	4.07	4.31	4.22	3.55	3.00	2.81
Central Coalfields Ltd												
Kargali	2.44	2.18	2.04	1.94	1.72	1.60	1.35	1.05	1.01	1.02	0.79	0.69
Kathara	1.83	1.76	1.73	1.55	1.62	1.71	0.82	0.78	0.72	0.61	0.55	0.55
Swang	0.99	0.99	0.97	0.81	0.71	0.79	0.70	0.60	0.61	0.46	0.41	0.43
Gidi	1.80	1.79	1.95	1.64	1.79	0.16	0.96	0.92	0.93	0.68	0.62	0.04
Rajrappa	1.71	1.70	2.18	2.42	2.13	2.13	0.97	0.90	1.23	1.39	1.01	0.98
Kedla	0	0	0	0.01	0.62	1.00	0	0	0	0	0.25	0.39
Total	8.77	8.42	8.87	8.37	8.59	7.39	4.80	4.24	4.50	4.15	3.63	3.08
Western Coalfields Ltd												
Nandan	0.61	0.68	0.69	0.65	0.68	0.66	0.37	0.39	0.42	0.41	0.39	0.35
Coal India Ltd												
Durgapur Steel Plant	17.16	17.16	16.96	15.95	15.65	14.28	9.24	8.94	9.14	8.11	7.02	6.24
Durgapur Steel Plant Washery	0.47	0.41	0.24	0.12	0.14	0.41	0.30	0.27	0.19	0.09	0.10	0.31
Durgapur Power Ltd												
Durgapur Power Limited Washery	0.01	0.01	0	0	0	0	0.01	0.01	0	0	0	0
Indian Iron and Steel Company												
Chasnala	1.16	1.11	1.00	0.85	1.03	1.14	0.59	0.58	0.54	0.50	0.58	0.63
Total	1.64	1.53	1.24	0.97	1.17	1.55	0.90	0.85	0.73	0.59	0.68	0.68
Public sector	18.80	18.69	18.20	16.92	16.85	15.83	10.13	9.79	9.87	8.70	7.70	7.20
Tata Iron and Steel Company												
West Bokaro I	0.61	0.51	0	0	0	1.87	0.34	0.29	0	0	0	0
West Bokaro II	1.90	1.78	1.72	1.82	1.87	1.94	0.72	0.67	0.62	0.66	0.69	0.77
West Bokaro III	0	0.43	1.81	2.13	2.07	1.43	0	0.16	0.63	0.75	0.74	0.71
Jamadoba	1.38	1.33	1.27	1.36	1.24	–	0.93	0.84	0.80	0.78	0.88	1.07
Total	3.89	4.05	4.80	5.31	5.18	5.24	1.99	1.96	2.05	2.19	2.31	2.55
Grand total	22.69	22.74	23.00	22.23	22.00	21.07	12.12	11.75	11.92	10.89	10.01	9.72

Source
CCO. ***Coal Directory of India*** (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.19 Availability and estimated sectorwise consumption of raw coal (million tonnes): 1990/91 to 1997/98

Items	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Availability								
Production	213.90	232.80	242.00	248.68	257.8	273.4	286.1	297.2
Imports[b]	5.71	5.92	6.26	7.10	8.3	8.9	9.5	9.5
Exports	0.10	0.11	0.13	0.10	0.1	0.1	0.1	0.1
Pithead stock (opening)	37.64	42.47	48.53	51.39	50.8	47.5	45.6	42.0
Pithead stock (closing)	42.47	48.53	51.31	50.75	47.5	45.6	42.0	41.5
Adjustment of pithead stock								
Industrial stock (opening)	6.21	5.25	5.50	0	0	0	0	0
Industrial stock (closing)	5.25	5.48	0	0	0	0	0	0
Available for industrial consumption after adjustment of off-take	213.30	228.87	241.79	255.90	269.2	284	299	307.1
Consumption/supply (raw coal)								
Steel and washery	30.91	34.03	37.30	37.63	38.6	39.1	39.8	39.8
Railways	5.24	5.06	4.34	2.00	0.67	0.3	0.1	0.1
Electricity (excluding middlings)	113.71	126.84	138.57	154.41	160.9	184.5	199.6	205.5
Cement	10.43	10.80	11.70	11.07	12.4	11.1	10.1	10.1
Cotton	2.58	1.96	1.90	1.81	1.8	1.2	1.3	1.3
Jute	0.12	0.12	0	0	0	0.1	0.1	0
Paper[a]	2.81	2.67	2.56	2.90	3.2	3.2	3.5	3.4
Brick	1.71	1.75	1.65	1.54	1.0	0.9	1.0	1.6
Coal for soft coke	1.20	1.03	0.97	0.44	0.3	0.3	0.3	0
Other industries	40.58	40.51	38.71	39.53	46.7	40.0	39.8	42.1
Colliery consumption	4.07	4.10	3.99	4.71	3.7	3.5	3.4	3.1
Total consumption	213.30	228.87	241.75	255.90	269.3	284.2	299.0	307.1

[a] includes only rail despatches

[b] only coking coal imports

Source

CCO. *Coal Directory of India* (various issues). Calcutta: Coal Controller's Organization, Ministry of Coal.

For more details, please see TEDDY ONLINE+ [Section: Coal (general)]

Table 1.20A Supply (thousand tonnes) of coal to steel plants: 1995/96 to 1996/97

Steel plant	1995/96 Prime coking coal	Medium coking coal	Blendable coking coal	Total	Boiler coal	1996/97 Prime coking coal	Medium coking coal	Blendable coking coal	Total	Boiler coal
Bhilai steel plant	1,088 3	1,381.5	239 2	2,709.0	629.9	892.4	1,273.2	205 0	2,370 6	779 4
Bokaro steel plant	978.0	992.4	7.8	1,978.2	1,674.5	900.1	1,252.1	0	2,153.0	1,602.9
Durgapur steel plant	726.9	548.4	21.1	1,296.4	384.4	622.0	448.6	8.7	1,079 3	549.3
Indian Iron and Steel Company	900 0	483.7	66.9	1,450.6	195.2	777.1	419.3	73 6	1,270.0	248.1
Rourkela steel plant	618.5	686.2	8.6	1,313.3	1,199.3	356.2	714.1	0	1,070 3	1,302.2
Steel Authority of India Ltd (Total)	4,311.7	4,092.2	343.6	8,747.5	4,083.3	3,547.8	4,108.1	287.3	7,943.2	4,481.9
Tata Iron and Steel Company Ltd	681.6	1,172.9	46.9	1,901.4	635.8	378.0	590 0	17.0	985.0	1,474 2
Visakhapatnam Steel Plant	20.9	915.8	0	936.7	1,194.4	75.7	750 5	0	826.2	1,351.8
Grand total	5,014.2	6,180.9	390.5	11,585.6	5,913.5	4,001.5	5,448.6	304.3	9,754.4	7,307.9

Source
CCO. 2000. ***Coal Directory of India 1999/2000***. Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.20 B Supply (**thousand tonnes**) of coal to steel plants: 1997/98 to 1998/99

Steel plants	1997/98					1998/99				
	Prime coking coal	*Medium coking coal*	*Blendable coking coal*	*Total*	*Boiler coal*	*Prime coking coal*	*Medium coking coal*	*Blendable coking coal*	*Total*	*Boiler coal*
Bhilai steel plant	893	1,084	165	2,142	760	748	1,112	32	1,892	704
Bokaro steel plant	901	1,204	0	2,105	1,483	854	1,085	–	1,939	1,398
Durgapur steel plant	532	396	0	928	671	686	405	6	1,097	624
Indian Iron and Steel Company	636	356	42	1,034	209	659	257	48	964	175
Rourkela steel plant	344	570	0	914	1,364	360	590	–	950	1,292
Steel Authority of India Ltd (Total)	3,306	3,610	207	7,123	4,487	3,307	3,449	86	6,842	4,193
Tata Iron and Steel Company Ltd	900	1,427	3	2,330	1,450	1,079	1,479	–	2,558	1,400
Visakhapatnam Steel Plant	0	619	0	619	1,434	–	386	–	386	1,721
Grand total	4,206	5,656	210	10,072	7,371	4,386	5,314	86	9,786	7,314

Source

CCO 2000 ***Coal Directory of India 1999/2000***. Calcutta: Coal Controller's Organization, Ministry of Coal.

Table 1.21 Inter-modal split of coal movement: 1977/78 to 1999/2000

	1977/78		*1995/96*		*1996/97*		*1997/98*		*1998/99*		*1999/2000*[a]	
Mode	*MT*	%	*MT*	%	*MT*	%	*MT*	%	*MT*	%	*MT*	%
Rail	78	78	156	56	165	57	176	57.14	164	54.85	127	56.44
Road	17	17	54	19	52	18	54	17.53	53	17.73	37	16.44
Belt	2	2	6	2	6	2	9	2.92	11	3.68	7	3.11
Ropeway	1	1	6	2	5	2	6	1.95	6	2.01	4	1.78
Merry-go-round	2	2	56	21	59	21	63	20.45	65	21.74	50	22.22
Total	100	100	280	100	287	100	308	100.00	299	100.00	225	100.00

MT - million tonne

[a] April-November

Source

MoC. 2000. ***Annual Report 1999/2000***. New Delhi: Ministry of Coal.

Table 1.22 Capacity and traffic handled at major ports (**million tonnes**): 1998/99

Port	*Capacity*		*Traffic handled*	
	All commodity	*Only coal*	*All commodity*	*Only coal*
Calcutta	8.3	–	9	–
Chennai	26.6	–	35	9.9
Haldia	22.7	6.8	20	7.1
Jawaharlal Nehru	16.0	–	12	–
Kandla	37.0	–	41	0.7
Kochi	13.0	–	13	0.2
Mormugao	18.7	–	18	0.3
Mumbai	31.0	–	31	–
New Mangalore	17.0	–	14	0.1
Paradip	11.0	4.8	13	7.9
Tuticorin	8.0	4.0	10	4.5
Vishakapatnam	30.0	–	36	8.4

Source

MoST. 1999. ***Basic Port Statistics of India 1998/99*** New Delhi: Ministry of Surface Transport.

Oil and gas

EXPLORATION AND PRODUCTION

Table1: Proven and balance reserves of crude oil(million tonnes)and natural gas (billion cubic meters) by state: 1994 to 1999

CRUDE OIL	1994	1995	1996	1997	1998	1999
ONSHORE						
ASSAM	156.06	147.87	154.33	189.63	160.39 -	
GUJARAT	153.4	153.2	152.08	150.91	148.02 -	
TOTAL	**309.46**	**301.07**	**306.41**	**340.54**	**308.41**	**308**
OFFSHORE						
BOMBAY HIGH	455.17	431.08	422.28	405.17	404.49	352
GRAND TOTAL	**764.63**	**732.15**	**728.69**	**745.71**	**712.9**	**660**
NATURAL GAS						
ONSHORE						
ASSAM	156.13	159.18	173.75	182.78	187.73 -	
GUJARAT	92.13	89.98	87.95	86.51	84.24 -	
RAJASTHAN	3.82	4.11	4.47	4.51	4.44 -	
TOTAL	**252.13**	**253.17**	**266.17**	**273.8**	**276.41**	**279**
OFFSHORE						
BOMBAY HIGH	454.56	406.47	377.17	418.26	398.34	369
TOTAL	**706.69**	**659.64**	**643.34**	**692.06**	**674.75**	**648**

Source:Indian Petroleum Statistics,1998-99

State-wise production of oil(million tonnes) and gas(billion cubic meters)

			CRUDE OIL				OFFSHORE		
YEAR	ARUNACHAL PRADESH	TAMIL NADU/A.P	ASSAM/ NAGALAND	GUJARAT	RAJASTHAN	TOTAL	BOMBAY HIGH	A.P.	TOTAL
1994	37	639	5108	6222		12006	18900		30906
1995	27	491	5038	6318		11934	22656	458	35048
1996	36	390	4834	6278		11538	20528	925	32989
1997	27	374	5058	6009		11468	20088	2274	33830
1998	29	444	5273	5946		11692	18606	2674	32972
YEAR									
1994			156.18	92.13	3.82	252.13	454.56		706.69
1995			159.18	89.88	4.11	253.17	406.47		659.64
1996			173.75	87.95	4.47	266.17	377.17		643.34
1997			182.78	86.51	4.51	273.8	418.26		692.06
1998			187.73	84.24	4.44	276.41	398.34		674.75

Source: Indian Petroleum Statistics,1998-99

Production(thousand tonnes) of petroleum products

PRODUCTS	1994	1995	1996	1997	1998	1999
LIGHT DISTILLATEAS	11326	12258	12815	12957	13328	12431
LPG	1394	1533	1566	1661	1676	1569
MS	4097	4367	4597	4876	5247	4381
NAPHTHA	5466	5924	6157	6015	6006	5764
SBPS/HEXANE	121	132	165	157	143	717
MIDDLE DISTILLATES	28788	29560	31661	33587	34989	31554
KEROSENE	5206	5315	5969	6357	6003	3859
ATF	1992	2026	2165	2155	2224	1625
HSD	19676	20348	21643	23304	24984	24508
LDO	1419	1364	1288	1237	1333	1152
JBO	82	92	96	99	77	81
MTO	157	169	210	197	178	194
HEAVY DISTILLATES	12758	12561	13393	14087	14492	55623
FO	5798	5512	5728	6435	6471	5026
LSHS/HHS/RFO	44062	4092	4360	4340	4482	3522
TOTAL FUEL OILS	9860	9604	10088	10775	10953	8548
LUBE OIL	529	582	601	588	644	515
BITUMEN	1904	1922	2229	2214	2339	1739
PET. COKE	258	259	243	266	287	286
PARAFIN WAX	43	43	33	32	34	40
OTHER WAXES	59	61	51	59	50	63
TOTAL WAXES	102	104	84	91	84	103
TOTAL PROD.	52872	54379	57869	60631	62809	64544
CRUDE RUN	56407	57971	61704	64533	66672	68538

Source: Indian Petroleum Statistics, 1998-99

PETROLEUM REFINING CAPACITY(million tonnes)

REFINERY	YEAR OF COMMISSIONING	INSTALLED CAPACITY AS ON 1.4.1999
IOC,DIBBOI	1901	0.65
BPCL,MUMBAI	1955	6.9
HPCL,MUMBAI	1954	5.5
HPCL,VISAKH	1957	4.5
IOC,GUWAHATI	1962	1
IOC,BARAUNI	1964	3.3
IOC,GUJRAT	1965	9.5
IOC,HALDIA	1974	3.75
IOC,MATHURA	1982	7.5
IOC,PANIPAT	1998	6
CRL,MADRAS	1966	7.5
MRL,MADRAS	1969	6.5
BR&PL,ASSAM	1979	2.35
MRL,NARIMANAM	1993	0.5
MR&PL,MANGLORE	1996	3.69
TOTAL		61.55
UNDER IMPLEMENTATION		
ASSAM,NUMALIGARH	1999	3

Source:Indian Petoleum Statistics, 1998-99

REFINING

Refining capacity, throughput and production(000` tonnes)

	CRUDE THROUGHPUT			PRODUCTION		
YEAR	SECTOR	PRIVATE SECTOR	TOTAL	SECTOR	PRIVATE SECTOR	TOTAL
1994	56534		56534	52872		52872
1995	58702		58702	55058		55058
1996	59959	2911	62870	56370	2635	59005
1997	61313	3853	65166	57736	3552	61308
1998	64469	4069	68538	60807	3737	64544

Source:Indian Petroeum Statistics,1998 99

Refinery-wise crude run and total production of petroleum products(000` tonnes)

YEAR		IOC	BPCL	HPCL[MUM]	HPCL[VISAKH]	IOC[GUWAHATI]	IOC[BARAUNI]	IOC[GUJRAT]	IOC[HALDIA]	IOC[MATHURA]	IOC[PANIPAT]	CRL[COCHIN]	MRL[MADRAS]	MRL[NARIMANAM]	BRPL[ASSAM]	MRPL[MANGALORE]	TOTAL
1994	TOTAL PROD	509	7071	4913	4759	833	2039	9148	2998	8018		4803	6461	370	1005		52927
	CRUDE RUN	536	7506	5234	5014	884	2220	9888	3258	8377		5135	6921	382	1179		56534
1995	TOTAL PROD	537	7065	5674	4753	781	2129	9476	3168	7934		7010	5162	358	1011	23	55081
	CRUDE RUN	559	7460	5965	5037	839	2322	10167	3416	8332		7421	5599	370	1215	39	58741
1996	TOTAL PROD	453	7279	6238	4576	778	1720	9722	3189	7744		6890	6143	332	1306	2635	59005
	CRUDE RUN	477	7640	6534	4847	848	1895	10352	3451	8113		7293	6621	345	1542	2915	62870
1997	TOTAL PROD	479	7591	6053	2308	779	1989	10043	4445	8302		7312	6437	533	1485	3552	61308
	CRUDE RUN	502	7996	6378	2467	856	2181	10694	470	8565		7729	6965	556	1718	3853	65166
1998	TOTAL PROD	524	8531	4955	3637	772	2017	10346	4432	8665	1908	7304	5652	619	1445	3737	64544
	CRUDE RUN	553	8878	5203	3861	836	2204	10935	4714	8909	2208	7770	6101	644	1653	4069	68538

Source:Indian Petroleum Statistics,1998-99

DEMAND/IMPORTS

Consumption/sales of petroleum products during 1994-98(000' tonnes)

	1994	1995	1996	1997	1998
LIGHT DISTILLATES	11259	12781	14034	15268	17232
LPG	3346	3741	4121	4451	4887
MO GAS	4037	4527	4932	5107	5430
NAPHTHA	3258	3685	3795	4453	5973
SBP/HEXANE	141	166	212	222	174
OTHERS	477	686	974	1034	768
MIDDLE DISTILLATES	40280	43991	47826	49923	50905
KEROSENE	8931	9276	9627	9743	10460
ATF	1870	2014	2172	2111	2101
HSD	27623	30898	34275	36400	36619
LDO/MDO	1396	1318	1233	1212	1266
JBO/WASH OIL	83	94	94	93	81
MTO	149	162	195	185	186
OTHER	228	229	231	179	192
HEAVY ENDS	12741	13497	14207	14272	14796
FO/TDO	5639	6361	6502	6570	6745
LSHS/HHS	4086	4080	4282	4346	4390
FUEL OIL	9725	10441	10784	10916	11135
LUBES &GREASES	657	704	690	786	848
BITUMEN/ASPHALT	1800	1913	2206	2174	2343
PETROLEUM COKE	199	254	329	227	286
WAX	129	135	122	87	85
OTHERS	231	50	76	82	99
TOTAL	64280	70269	76067	79464	82933
REFINERY FUEL	3093	3217	3217	3433	3574
GRAND TOTAL	67373	73486	79500	82982	86507

Source: Indian Petroleum Statistics,1998-99

IMPORT/EXPORT OF CRUDE

YEAR	CRUDE OIL		PETROLEUM PRODUCTS		TOTAL	
	QTY. (000' tonnes)	VALUE (Rs Crore)	QTY. (000' tonnes)	VALUE (Rs Crore)	QTY (000' tonnes)	VALUE (Rs Crore)
GROSS IMPORTS						
1994-1995	27348	10682.52	13951	7521.71	41300	17837
1995-1996	27342	10316	20335	12577.85	47677	24094.94
1996-1997	33906	11517	20265	16533.49	54171	34171.98
1997-1998	34494	18538	19530	12431.92	54024	28329.07
1998-1999	34808	15897	18780	9836.52	58588	24712.56
EXPORTS						
1994-1995	-	-	3254	1587.36	3254	1587.36
1995-1996	-	-	3435	1831.98	3435	1831.93
1996-1997	-	-	3162	2084.78	3162	2034.71
1997-1998	-	-	2950	1822.84	2954	1822.84
1998-1999	-	-	1401	855.71	1401	855.71
NET IMPORTS						
1994-1995	27349	10316.06	10697	5934.33	38046	16250.36
1995-1996	27342	11517	16900	10745.95	44242	22262.92
1996-1997	33906	18538.19	17103	13548.71	51009	32086.9
1997-1998	34494	15897.15	16576	10609.08	51070	26506.23
1998-1999	39808	14876.46	17379	8990.81	57187	23857.27

Source: Indian Petroleum Statistics,1998-99

Imports and exports of crude oil and petroleum products

	1995 QTY.	1995 VAL.	1996 QTY.	1996 VAL.	1997 QTY.	1997 VAL.	1998 QTY.	1998 VAL.
GROSS IMPORTS								
CRUDE OIL	26901	10856.71	32812	17194.53	33573	17061.19	38607	14513
PETROLEUM PRODUCTS			-					
LIGHT DISTILLATES	932	702.53	1186	1010.73	1582	1571.53	1792	1319.13
NAPHTHA	-		-				40	23.68
OTHERS	932	702.53	1186	1010.73	1582	1571.53	1752	1295.45
MIDDLE DISTILLATES	16084	9109.4	18520	13886	17850	12348.96	17259	8857
ATF	120	81.5	178	141.92	31	25.35	31	18.86
SKO	4923	3033.85	4315	3506.75	3803	2853.93	5446	3068.31
HSDO	11040	5994.06	14028	10237.34	14016	9469.67	11782	5770.29
HEAVY ENDS	916	439.06	1058	557.89	407	210.98	532	231.83
FO	850	308.3	1058	557.89	358	136.71	514	182.85
LUBES	62	123.58	1009	425.82	29	74.27	18	49.02
WAXES	4	7	49	132.07	-	-	-	-
OTHERS	-	-	-	-	-	-	-	-
TOTAL	17931	10251.01	20764	15454.63	19839	14131.47	19583	10408.42
GRAND TOTAL	44832	21107.72	53576	32649.16	53412	31192.66	58190	24922.19
EXPORTS								
CRUDE OIL	-	-	-					
PETROLEUM PRODUCTS								
LIGHT DISTILLATES	2905	1461.89	2819	1714.36	2221	1475.11	1167	607.21
NAPHTHA	2372	1219 15	2355	1435.72	1590	1076 82	874	440.22
OTHERS	533	242.74	464	278 68	631	398 29	293	166 99
MIDDLE DISTILLATES	389	255.64	421	295.32	456	388.66	526	435.17
HSD/LDO	206	133.9	212	145 01	237	212 99	261	212.1
OTHERS	183	121.74	209	150.31	219	175.67	265	223.07
HEAVY ENDS	24	11.02	86	40.82	156	63.07	223	51.21
FO	24	10 88	86	40.39	155	62.9	203	47 99
OTHERS	-	0 14	NIL	0 23	1	0 17	29	3 22
TOTAL	3318	1728.55	3326	2050.49	2833	1926.84	1916	1093 59
GRAND TOTAL	3318	1728.55	3326	2050.49	2833	1926.84	1916	1053.59
NET IMPORTS								
CRUDE OIL	26901	10856.71	32812	17194 53	33573	17061.91	38607	14513 77
PETROLEUM PRODUCTS	14613	8522.46	17438	13404.14	17006	12304.63	17667	9314.83
TOTAL	41514	19379.17	50250	30598.67	50579	29365.82	56274	23828.6

Source: Indian Petroleum Statistics 1998-99

Royalty and oil development cess paid by oil companies on crude oil and natural gas

YEAR	ROYALTY PAID ON CRUDE OIL(Rs/lakhs)						ROYALTY PAID ON NATURAL GAS					
	WESTERNREGION	EASTERN REGION	SOUTHERN REGION	TOTAL ONSHORE	BOMBAY HIGH	TOTAL	WESTERN REGION	EASTERN REGION	SOUTHERN REGION	BOMBAY HIGH	TOTAL	OIL DEV. CESS
1995	32041	25660	2245	59946	96157	156103	2975	422	854	18154	22405	264559
1996	32716	25239	2182	60137	103576	163713	3753	457	958	21952	27118	277735
1997	34897	26305	2400	63602	105549	169151	3661	403	1262	22004	27330	266747
1998	34210	27951	2531	64652	115390	180042	4839	675	2065	33956	41535	283757
1999	33256	27972	3033	64261	106739	17100	4831	982	2301	35667	43781	275385

Source:Indian Petroleum Statistics,1998-99

Realization of excise/customs duties and sales tax from petroleum products(Rs crore)

PRODUCTS	1995	1996	1997	1998
EXCISE DUTY				
MOTOR SPIRIT	1631	2117	2942	4427
KEROSENE OIL	258	647	226	409
REF. DIESEL OIL	1155	1962	2052	2666
DIESEL OIL	86	123	145	214
FURNACE OIL	146	289	544	335
POL. PRODUCTS	733	881	1899	2390
PETROLEUM GASES	276	382	397	417
CESS ON CRUDE OIL	2880	2675	2740	2556
TOTAL	7159	9076	18945	13414
CUSTOM DUTIES				
CRUDE PETROLEUM	4852	5740	4867	3647
PETROLEUM PRODUCTS	4491	5784	5159	5162
TOTAL	8453	11524	10026	8809
GRAND TOTAL	15612	20600	20971	22223

Source: Indian Petroleum Statistics,1998-99

Sales tax rates applicable on crude oil, natural gas and petroleum products(%)

PRODUCTS CRUDE OIL &GAS	ANDRA PRADESH	ARUNACHAL PRADESH	ASSAM	BIHAR	GOA	GUJRAT	HARYANA	HIMACHAL	J&K	KAR.	KERALA	M.P	MANIPUR	MIZO.	NAGALAND	ORISSA	PUNJAB	RAJ.	TRIPURA	U.P	CHANDI.	DELHI
CRUDE OIL	4	NO TAX	4	4	4		4	4	4	4	4	4	4	-	-	4	4	4	4	4	4	4
NATURAL GAS	16	NO TAX	10	9	8		10	8	8	8	10	-	-	-	-	-	8	8	-	10	8	7
PETROLEUM PRODUCTS																						
AVIATION SPIRIT	30 55	NO TAX	25	25	20		10	6	8	22	20	20	10	-	-	20	8	20	25	20	15PPL	11
ATF	30 55	NO TAX	25	25	20		10	6	8	22	20	20	10	-	15	20	8	20	25	20	15PPL	11
MS	30 55	NO TAX	17	16	17		10	6	8	22	17	20	15	8	8	18	12	20	8	20	15PPL	11
HSD	19 33	NO TAX	16	15	17		10	6	8	20	15	20	7	5	3.25	18	4	16	5	20	10PPL	11
LDO	19 33	NO TAX	16	15	17		10	8	8	20	25	12	7	-	3.25	16	8	16	-	20	8	11
MLO	19 33	NO TAX	10	9	8		10	8	8	10	12.5	6	-	-	-	12	8	8	-	15	7	6
SKO	8	NO TAX	2	6	NO		10	8	-	4	5	2	3	-	1.15	EXEMPT	8	8	5	10	8	10
IKO	-	NO TAX	-	8	-			-	8	8	-	-	7	-	-	-	8	8	-	10	-	7
FO	12	NO TAX	8	9	17		10	8	8	10	12 5	8	NA	-	-	12	8	8	-	7 5	8	11
MTO	16	NO TAX	10	16	8		10	8	8	10	12 5	8	10	8	-	12	8	16	-	15	8	11
LUBES	16	NO TAX	12	16	8		10	8	8	10	15	12	7	-	8	16	12	12	12	10	8	11
GREASES	16	NO TAX	12	9	8		10	8	8	10	15	12	4	-	8	16	12	12	12	10	8	7
PETROLEUM NAPHTHA	16	NO TAX	10	9	17		10	8	8	10	7	8	7	-	-	12	8	8	-	15	8	7
BITUMEN	16	NO TAX	10	4	8		10	8	8	4	12 5	8	4	-	-	8	8	8	5	10	4	4
PETROLEUMCOKE	4	NO TAX	4	9	2		10	8	8	4	4	4	7	10	-	4	4	4	12	10	8	4
INDANE	16	NO TAX	12	9	EX.2		10	8	8	10	10	12	7	-	8	12	8	12	12	15	8	7
TRANSFORMER OIL	16	NO TAX	10	9	8		10	8	8	10	12.5	12	-	-	-	12	8	8	12	10	8	7
HB FLUID	16	NO TAX	10	9	8		10	8	8	10	15	15	-	-	-	-	8	8	-	4	8	7
LSHS	16	NO TAX	10	9	17		10	8	8	10	12.5	6	-	-	-	-	8	8	-	10	8	7

Source Indian Petroleum Statistics,1998-99

Development of basic ceiling selling price(Rs per selling unit) of petroleum products

PRODUCT	SELLING UNIT	EFFECTIVE DATE			
		1 4/98	[illegible] 6/98	[illegible]/2/99	28/2/99
ATF	KL	10838	10838	10838	10759
MS	-	17055	15495	15495	15399
MS-93	-	20180	18335	18335	18239
HSDO	-	7839	7537	6722	6622
SKO	-	2001	2001	2001	2001
LDO	-	7201	7201	6300	6300
FURNACE OIL	-				
FOR NON FERT.	-	4801	4801	4801	4050
FOR FERT	-	4801		NA	
LSHS	MT				
FOR FERT	-	5071	5071	4580	4340
FOR NON FERT	-	5071	N.A	NA	
BITUMEN	MT				
BULK	-	$5,600	5600	5600	5600
PACKED	-	$7,050	7050	7050	7050
NAPHTHA	MT				
FOR NON FERT	-	7072	7072	6820	6820
FOR FERT	-	7072	7072	6820	6820
LPG	MT				
DOMESTIC	-	7958	7958	8944	8733
NON DOMESTIC	-				
NON ESSN	-	10015	12669	12669	12669

Source.Indian Petroleum Statistics,1998-99

Trends in retail selling prices of selected petroleum products in India

PRICES AS ON	MOTOR SPIRIT(Rs/litre)				
	BOMBAY	CALCUTTA	DELHI	MADRAS	KANPUR
8/4/95	19.26	17.68	16.8	19.98	18.12
1/4/96	19.26	17.67	16.95	19.98	18.12
1/4/97	24.03	22.05	21.13	24.91	22.4
1/4/98	25.79	23.54	22.84	26.79	23.76
1/4/99	28.25	24.56	24.01	27.99	26.06
PRICES AS ON	HSD(Rs/litre)				
	BOMBAY	CALCUTTA	DELHI	MADRAS	KANPUR
8/4/95	7.84	7.25	6.99	7.8	7.69
1/4/96	7.84	7.24	6.99	7.8	7.69
1/4/97	9	8.32	8.02	8.86	8.65
1/4/98	11.84	10.55	10.25	11.3	10.85
1/4/99	11.84	10.18	10.03	10.91	10.92
PRICES AS ON	SUPERIOR KEROSENE(Rs/litre)				
	BOMBAY	CALCUTTA	DELHI	MADRAS	KANPUR
8/4/95	2.55	2.8	2.57	2.8	2.85
1/4/96	2.55	2.8	2.58	2.8	2.85
1/4/97	2.55	2.8	2.58	2.8	2.8
1/4/98	2.55	3.05	2.56	2.8	2.79
1/4/99	2.63	3.01	2.51	2.76	2.75
PRICES AS ON	LPG(Rs/cylinder)				
	BOMBAY	CALCUTTA	DELHI	MADRAS	KANPUR
8/4/95	91.94	105.27	93.28	97.55	98.37
1/4/96	94.4	107	93.08	98.05	98.9
1/4/97	118.6	136.65	119.95	124.1	126.25
1/4/98	137.85	158.55	136	145.05	144.38
1/4/99	147.85	170	146	155.35	154.95

Source:Indian Petroleum Statistics,1998-99

Marketing and distribution of products

Movement of petroleum products by railways

	1994	1995	1996	1997
TONNES ORIGINATING [000 TONNES]	25950	27724	28909	28590
AVERAGE LEAD DISTANCE(Km)	638	655	667	656
EARNINGS[PAISE/TONNE-Km]	88.9	99.1	103.7	111.2

Source:Teddy,1999-2000

Petroleum products handled at major ports (million tonnes)

PORTS	Capacities as on March 1998	1996/97	1997/98	Utilisation in 1997/98[%]
CALCUTTA	3.1	2.5	3.8	121
HALDIA	8.5	8.5	10.6	124
KANDLA	23	25.1	29	126
KOCHI	10.5	9.2	9.8	93
MADRAS	8.5	12.5	11.6	136
MORMUGAO	1.5	1.2	1.1	75
MUMBAI	21	18.9	16.7	80
NEW MANGLORE	7.5	4.9	6.5	87
PARADIP	0.7	1.7	1.7	249
TUTICORIN	1.1	0.4	0.4	36
VISAKH	11.5	13.4	12.1	105
TOTAL	96.9	98.1	104	107

SOURCE:Teddy,1999-2000

Product storage and movement

Mode of transport

	1993/94	1994/95	1995/..	1996/97	[illegible]
ROAD					
MILLION TONNES					
PERCENTAGE	15.3	17.9	22.2 -	-	
RAIL	25.2	27.3	30.6 -	-	
MILLION TONNES					
PERCENTAGE	26.1	28	30.2	29.6	32
PIPELINE	42.9	42.8	41.7	38.3	39.9
MILLION TONNES					
PERCENTAGE	15	15.4	15.9	19.2	20.7
COASTAL	24.7	23.5	21.9	24.9	16.6
MILLION TONNES					
PERCENTAGE					
	4.9	4.6	5.5 -	-	
	8.1	7	7.6 -	-	
MARKETING INFRASTRUCTURE					
TOTAL NO.OF TER. AND DEPOTS					
TOTAL NO.OF BOTTLING PLANTS		333			
EXISTING		98			
TANKAGE		115			
		13.86			

Source: Teddy,1999-2000

Natural Gas/LNG/CNG

Sector-wise offtake(million cubic meters) of Natural Gas by industries

INDUSTRY	1994/95	1995/96	1996/97	1997/98	1998/99
ENERGY PURPOSES					
POWER GENERATION	5229	6836	6935	8067	8714
INDUSTRIAL FUEL	1927	2301	2631	1719	3005
TEA PLANTATION	134	111	130		147
DOMESTIC FUEL	190	178	184		193
CAPTIVE USE/LPG	2230	589	618	920	911
TOTAL	**9710**	**10015**	**10498**	**10705**	**12970**
NON ENERGY PURPOSES					
FERTILIZER INDUSTRY	6936	7602	7625	8753	8869
PETROCHEMICALS	520	474	509 -		650
OTHERS	173		-		
TOTAL	7629	8076	8134	8753	9519
GRAND TOTAL	17339	18091	18632	19458	22489

Source:Teddy,1999-2000

Production (million cubic metres) of natural gas: 1995/96 to April-December 1999

State	*1995/96*	*1996/97*	*1997/98*	*1998/99*	*1999*
Natural gas production					
Onshore					
Gujarat	2,878	2,932	3,115	3,166	2,354
Assam / Nagaland	1,880	1,941	2,018	2,055	1,563
Arunachal Pradesh	32	23	24	24	17
Tripura	131	154	196	307	268
Tamil Nadu	117	92	95	107	98
Andhra Pradesh	679	799	1,022	1,218	1,027
Rajasthan	12	10	148	163	109
Total	5,729	5,951	6,618	7,040	5,436
of which					
Oil India Ltd	1,433	1,467	1,670	1,713	1,288
ONGC (Oil and Natural Gas Corporation Ltd)	4,296	4,484	4,948	5,237	4,148
Offshore					
ONGC	16,579	16,794	18,102	17,514	13,271
Private/Joint venture company	331	510	1,681	2,874	2,641
Grand total	22,639	23,255	26,401	27,428	21,348

[a] includes Tripura, Tamil Nadu, and Andhra Pradesh

Sources

1 MoPNG 1999 ***Basic Statistics on Indian Petroleum & Natural Gas.*** New Delhi Ministry of Petroleum and Natural Gas.

2 MoPNG 1999 ***Annual Report 1999/2000*** New Delhi Ministry of Petroleum and Natural Gas

Power

Table 1 Installed capacity of utilities by region and state (MW) 31 March 2000

State/union territory/central sector	*Hydro*	*Steam*	*Gas*	*Diesel*	*Nuclear*	*Wind*	*Total*
Northern region							
Haryana	883.9	892.5	0	3.92	0	0	1780.32
Himachal Pradesh	299.37	0	0	0 13	0	0	299.5
Jammu and Kashmir	225.19	0	175	8.94	0	0	409.13
Punjab	1798.9	2130	0	0	0	0	3928.9
Rajasthan	971.1	1475	38.5	0	0	2	2486.6
Uttar Pradesh	1510.8	4542	0	0	0	0	6052.8
Chandigarh	0	0	0	2	0	0	2
Delhi	0	335	282	0	0	0	617
Central sector	2010	5400	0	0	1130	0	8540
Sub-total	**7699.2**	**14774.5**	**2663.5**	**14.99**	**1130**	**2**	**26284.19**
Western region							
Gujarat	547	4864	1635	17.48	0	166.91	7230.39
Madhya Pradesh	892.9	3437	0	0	0	22.59	4352.49
Maharashtra	2825.2	7655	1832	0	0	79.28	12391.48
Goa	0.1	0	48	0	0	0.11	48.21
Dadra and Nagar Haveli	0	0	0	0	0	0	0
Daman and Diu	0	0	0	0	0	0	0
Central sector	0	4360	1292	0	860	0	6512
Sub-total	4265.2	20316.5	4807	17.48	860	268.89	30535.07
Southern region							
Andhra Pradesh	2671.9	2952.5	542	0	0	88.04	6254.44
Karnataka	2685.6	1520	0	127.92	0	34.22	4367.74
Kerala	1752.5	0	135	228	0	2.02	2117.52
Tamil Nadu	1993.2	2970	130	200	0	758.44	6051.64
Lakshadweep	0	0	0	0	0	0	0
Pondicherry	0	0	32.5	0	0	0	32.5
Central sector	0	4170	350	0	690	0	5210
Sub-total	**9103.19**	**11612.5**	**1189.9**	**555.92**	**690**	**882.72**	**24034.23**
Eastern region							
Bihar	174.9	1813.5	0	0	0	0	1988.4
Orissa	1571.9	420	0	0	0	1.1	1993
West Bengal	164.01	4086.4	100	22.5	0	0	4372.91
Andaman and Nicobar Islands	0	0	0	5	0	0	5
Sikkim	32.9	0	0	0	0	0	32.9
Central sector	204	6547.5	90	0	0	0	6841.5
Sub-total	**2147.72**	**12867.4**	**190**	**27.5**	**0**	**1.1**	**15233.72**
North-eastern region							
Assam	2	330	269	20.69	0	0	621.69
Manipur	2.6	0	0	9.41	0	0	12.01
Meghalaya	186.7	0	0	2.05	0	0	188.75
Nagaland	3.5	0	0	2	0	0	5.5
Tripura	16.01	0	64.5	4.85	0	0	85.36
Arunachal Pradesh	29.55	0	0	15.88	0	0	45.43
Mizoram	5.31	0	0	20.36	0	0	25.67
Central sector	355.01	0	375	0	0	0	730.01
Sub-total	**600.7**	**330**	**708.5**	**75.24**	**0**	**0**	**1714.44**
Total Islands	**0**	**0**	**0**	**35.25**	**0**	**0**	**35.25**
All-India	**23816.01**	**59900.88**	**9558.9**	**726.38**	**2680**	**1154.71**	**97836.88**

Source

Central Electricity Authority.

A	*Hydro*	*Hirakud, D-Sambalpur*	307	307
		Balimela, D-Malkangiri	360	360
		Rengalli, D-Angul	250	250
		Upper Kolab, D-Koraput	320	320
		Machkund, Korapur	120	120
B	Thermal	IB T.P.S, D-Jharsuguda	420	420
	Sub -total (State)		1777	1777
	Central Sector			
	Thermal (NTPC)	Talcher	**1470**	**1460**
	Total (Orissa)		**3247**	**3237**
	NORTH EASTERN REGION			
1	**Assam**			
	State Sector			
A	Thermal	Bongaigaon, D-Goalpara	240	240
		Chanderpur D-Kamrup	60	60
		Namrup GT,D-Dibrugarh(Gas)	82	82
		Lakwa GT	120	120
	Sub total (State)		**502**	**502**
	Central			
A	Hydro	Kopili (Neepco)	200	200
B	Thermal	Kathalgun (Neepco)	201	201
	Sub-total (Central)		**401**	**401**
	Total capacity (Assam)		**903**	**903**
3	**Meghalaya**			
	State Sector			
	Hydro	Umtru-Umium ST-I, II, III &IV, D-Ribhoi	185	185
	Central Sector			
	Hydro	Khandong	50	50
	Total (Meghalaya)		**235**	**235**
4	**Manipur**			
	Central Sector	Loktak, D-Manipur	105	105

Source: CEA, Compendium of Power Generating Plants, July 1997

		Sholayar, D-Coimbatore	95	95
		Kodayar, D-Tirunelveli	100	100
		Kadamparai, D-Coimbatore	400	400
		Lower Mettur, D-Erode	120	120
B	Thermal	Ennore, D-Chengulput	450	450
		Tuticorin	1050	1050
		Mettur, D-Salem	840	840
		N. Madras, D-Chennai	630	630
		Basin Bridge GT, D-Chennai	120	120
	Sub total (State)		**4832**	**4832**
	Central Sector			
A	Thermal (NLC)	Neyveli Lignite, D-South Arcot	2070	2070
B	Nuclear	Kalpakam	470	340
	Sub total (Central)		**2540**	**2410**
	Pvt. Sector			
	Wind		656	656
	Sub total (Pvt. Sector)		**656**	**656**
	Total capacity (Tamil Nadu)		**8028**	**7898**
	EASTERN SECTOR			
1	**BIHAR**			
	State Sector (BSEB)			
A	Hydro	Sulemrekha	130	130
B	Thermal	Barauni, D-Begusarai	320	320
		Patratu, D-Hazanbagh	840	770
		Muzzafarpur	220	220
		Tenughat	420	420
	Sub total (State)		**1930**	**1860**
	Central Sector (DVC/NTPC)			
A	Hydro	Panchet Hill	80	80
B	Thermal (Coal)	Bokaro A&B (DVC)	878	790
		Chandrapur D-Gindih(DVC)	780	750
		Maithon, D-Dhanbad (DVC)	90	82.5
		Kahalgaon, D-Bhagalpur (NTPC)	840	840
	Sub total (Central)		**2668**	**2542.5**
	Total capacity (Bihar)		**4598**	**4402.5**
2	**West Bengal**			
	State Sector			
A	Hydro	Rammam,, D-Darjeeling	50	50
B	Thermal (Coal)	Bandel, D-Hoogly	540	530
		Santaldih, D-Purulia	480	480
		Kolaghat (WBPDCL), D-Midnapore	1260	1260
		Durgapur (DPL)	395	390
	Sub total (state sector)		**2725**	**2710**
	Central Sector			
A	Hydro	Maithon	60	60
B	Thermal	Durgapur	350	350
		Mejia, D-Bankura	420	420
		Farukkha , D-Murshidabad	1600	1600
	Sub total (Central)		**2430**	**2430**
	Pvt. Sector			
	CESC Thermal	Mulajore, D-Parganas (N)	120	120
	(Coal)	Titagarh, D-Parganas (N)	240	240
		Southern Gen. Calcutta	135	135
		New Cossipore, Calcutta	120	120
	Sub-total (Pvt.)		**615**	**615**
	Total capacity (West Bengal)		**5770**	**5755**
3	**Orissa**			
	State Sector			

A	Hydro	Bhivpuri, D-Raigad	72	72
		Khopoli, D-Raigad	72	72
		Bhira, D-Raigad	282	282
B	Thermal	Trombay, Bombay (Tatas)	1150	1150
		Trombay, Bombay (Tatas)	180	180
		Dhahanu (BSES)	500	500
	Sub total (Pvt.)		**2256**	**2256**
	Total Capacity (Maharashtra)		**10333**	**10204.5**
	SOUTHERN REGION			
1	**Andhra Pradesh**			
	State Sector (APSEB)			
A	Hydro	Upper Sileru PH, D-Vizag	240	240
		Lower Sileru, D-Kammam	460	460
		Srisalam	770	770
		N. Sagar Main PH, D-Nalgonda	810	810
		N. Sagar RBC & LBC PH, D-Guntur	150	150
B	Thermal (Coal)	Vijaywada, D-Krishna	1260	1260
		Kothagudam, D-Krishna	930	670
		Ramagundam, D-Karimnagar	62.5	62.5
		Rayalseema, D-Cudappa	420	420
C	Thermal (Gas)	Vijeswaram, D-West Godavari	99	99
	Sub total (State)		**5201.5**	**5191.5**
	Pvt. Sector			
A	Thermal (Gas)	Jegurupadu CCGT, Hyderabad	158.4	158.4
		Godavari, M/s Spectrum Power Gen Ltd.	94	94
	Sub total (Pvt.)		**252.4**	**252.4**
	Central Sector			
A	Thermal (Coal)	Ramagundam, D-Karimnagar	2100	2100
	Sub total (Central)		**2100**	**2100**
	Total capacity (A.P.)		**7553.9**	**7543.9**
2	**Karnataka**			
	State Sector (KPCL)			
A	Hydro	Jog	120	120
		Sharavati, Jogfalls, D-Shimoga	891	891
		Linganamakki, D-Shimoga	55	55
		Supa DPH, D-U.K	100	100
		Kalindi St-I, Nagjari PH, D-U.K	810	810
		Varahi	239	239
B	Thermal	Raichur TPS	840	840
		Bangalore (D.G. Sets)	128	128
	Total capacity (Karnataka)		**3183**	**3183**
3	**KERALA**			
	State Sector (KSEB)			
A	Hydro	Sholagar	54	54
		Sabirigin	300	300
		Kuttiadi	75	75
		Iduki	780	780
		Idumalayar	75	75
		Periyar	60	60
	Total capacity (Kerala)		**1344**	**1344**
4	Tamil Nadu			
	State Sector			
A	Hydro	Pykara, D-Nilgins	72	72
		Periyar, D-Tirunel Veli	140	140
		Kundah St. I-IV, D-Nilgins	555	555
		Mettur Tunnel, Erode	200	200
		Aliyar, D-Coimbatore	60	60

		Gandhinagar	660	660
		Wanakbori, D-Kheda	1260	1260
		Sikka REPL, D-Panandhro	240	240
		Kutch lignite	140	140
C	Thermal (gas)	Utran, D-Surat	144	144
		Dhuvran	54	54
	Sub Total (State)		4362	4356
	Central Sector			
A	Thermal (NTPC)	Kawas Gas	644	644
		Gandhar Gas.	648	648
B	Nuclear (NPC)	Kakrapar	440	440
	Sub Total (Central Sector)		1732	1732
	Private Sector			
A	Thermal (AECO)	Sabarmati, Ahmadabad	450	410
		Vatwa Vatwa Gas	99	99
B	Thermal (GIPCL)	GIPCL GT	145	145
		Hazira GT	330	330
C	Wind	Pvt.	130	130
	Sub total (Pvt. Sector)		1154	1114
	Total capacity (Gujarat) MW		7248	7202
2	**Madhya Pradesh**			
	State Sector (MPSEB)			
A	Hydro	Bargi, D-Jabalpur	90	90
		Ban Sagar Tons, D-Rewa	315	315
		Hasdeo Bango, D-Bilaspur	120	120
		Gandhi Sagar, D-Mandsaur	115	115
B	Thermal	Korba East-II,III & West	1280	1240
		Amarkantak-I&II, D-Shadhol	300	290
		Satpura-I, II & III, D-Betul	1142	1142
		Sanjay Gandhi, D-Shadhol	420	420
	Sub total (State)		3782	3732
	Central Sector			
A	Thermal	Korba, Bilaspur	2100	2100
		Vindhyachal	1260	1260
	Sub total (Central)		3360	3360
	Total (M.P.)		7142	7092
3	**Maharashtra**			
	State sector (MSEB)			
A	Hydro	Koyna St. I,II&III, D-Ratnagiri	880	880
		Vaitarna, D-Nasik	60	60
		Tillari, D-Kolhapur	60	60
		Bhira Tail Race, D-Raigad	80	80
		Pench, D-Nagpur	160	160
B	Thermal (Coal)	Koradi P.S, D-Nagpur	1100	1080
		Nasik	910	910
		Bhusawal, D-Jalgaon	482.5	478.5
		Paras, D-Akola	62.5	58
		Parli, D-Beed	690	690
		Khaperkheda, D-Nagpur	420	420
		Chandrapur	1840	1840
C	Thermal (Gas)	Uran GTPS, Raigad	672	672
		Uran WHR, D-Raigad	240	240
	Sub total (State)		7657	7628.5
	Central Sector			
	Nuclear	T A P.S, D-Thane	420	320
	Sub total (Central)		420	320
	Pvt. Sector			

B	Thermal (gas)	GNDTP, D-Bhatinda	440	440
		Ropar, Gananli, D-Ropar	1260	1260
	Sub total (State)		**2241**	**2241**
	Central Sector			
	A. Hydro	Kotla, D-Ropar	78	78
		Ganguwal, D-Ropar	77	77
	Sub total (Central)		**155**	**155**
	Total Capacity (Punjab)		**2396**	**2396**
5	**Rajasthan**			
	State Sector (RSEB)			
A	Hydro	Mahibajaj, D-Banswara	140	140
		R P Sagar, D-Kota	172	172
		Jawahar Sagar, D-Kota	99	99
B	Thermal (gas)	Kota, Shakatpura	850	850
	Sub total (State)		**1261**	**1261**
	Central Sector			
	Tharmal (Gas)	Anta, D-Baran	413	413
	Nuclear	RAPS, Kota	440	300
	Sub total (Central)		**853**	**713**
	Total Capacity (Rajasthan)		**2114**	**1974**
6	**Uttar Pradesh**			
	State Sector			
A	Hydro	Rihand, D-Bind	300	300
		Dhalipur Y St.I, D-Dehradun	51	51
		Obra	99	99
		Chibro Y St.II, D-Dehradun	240	240
		Ramganga, D-Paungarwal	198	198
		Khodri, D-Dehradun	120	120
		Chilla, D-Hardwar	144	144
		Manen Bhali, D-Uttarkashi	90	90
		Khara, D-Dehradun	72	72
B	Thermal (gas)	Harduaganj 'A', D-Aligarh	90	90
		Harduaganj 'B', D-Aligarh	220	200
		Harduaganj 'C', D-Aligarh	230	225
		Panki, Kanpur	284	270
		Obra, D-Sonebhadra	1550	1482
		Paricha, D-Jhansi	220	220
		Anpara A&B, D-Sonebhadra	1630	1630
		Tanda, D-Faizabad	330	330
	Sub total (State)		**5868**	**5761**
	Central Sector			
A	Hydro (NHPC)	Tanakpur	120	94
B	Thermal (NTPC)	Singrauli	2000	2000
		Rihand	1000	1000
		Unchahar	420	420
		Dadri	840	840
		Auraiya (gas)	652	652
		Dadri Gas	817	817
C	Nuclear	Narora Atomic Power Station	455	440
	Sub total (Central)		**6304**	**6289**
	Total Capacity (U P)		**12,172**	**12,050**
	WESTERN REGION			
1	**Gujarat**			
	State Sector (GEB)			
A	Hydro	Kadana	180	180
		Ukai, D-Surat	300	300
B	Thermal (Coal)	Dhuvram, D-Kheda	534	534
		Ukai TPS, D-Surat	850	850

Table 2: List of Generating projects (above 50 MW Capacity) as on 31st March, 1997

Sl No	Name of state	Name & Location of Plant	Capacity of the Generating Plant Rated (MW)	Derated (MW)
	NORTHERN REGION			
1	**Delhi**			
	State Sector (DVB)			
A	Thermal			
	1. Coal	I. P. Station, New Delhi	284	277
		Rajghat, New Delhi	150	149
	2. Gas	G.T. Plant- Rajghat, New Delhi	282	282
	Sub total (State)		716	708
	Central Sector			
B	Thermal (Coal)	Badarpur TPS, Badarpur	720	705
	Sub total (Central)		720	705
	Total capacity (Delhi)		1436	1413
2	**Haryana**			
	State Sector (HSEB)			
A	Thermal	Faridabad	180	165
		Panipat	650	650
	Total capacity (Haryana)		830	815
3	**Himachal Pradesh**			
	State Sector			
A	Hydro	Bassi, D-Joginder Nagar	60	60
		Giri Bata, D Giri Nagar	60	60
		Sanjay Bhabha, D-Bhaba Nagar	120	120
	Sub total (State)		240	240
	Central Sector (BBMB/NHPC)			
A	Hydro			
		Dehar	990	990
		Pong	360	360
		Bhakra (LB)	540	540
		Bhakra (RB)	660	660
		Baira Siul	180	180
		Chamera	540	540
	Sub total (Central)		3270	3270
	Total capacity (HP)		3510	3510
4	**Jammu & Kashmir**			
	State Sector			
A	Hydro			
		Lower Jhelum	105	105
	Thermal (gas)			
		Pampore, Srinagar	175	175
	Sub total (State)		280	280
	Central Sector			
	A. Hydro			
		Salal Reasi, D-Udhampur (J&K)	690	690
		URI, D-Baramula (J&K)	480	480
	Sub total (Central)		1170	1170
	Total Capacity (J&K)		1450	1450
4	**Punjab**			
	State Sector (PSEB)			
A	Hydro	Shanan, Joginder Nagar	110	110
		U.B.D.C New Pathankot	90	90
		Mukerian, D-Talwara, Hoshiarpur	207	207
		Anandpur Sahib, D-Ropar	134	134

Northern region													
Haryana	166267	0	0	1135	2153	0	1540	4357	0	53816	0	0	[illegible]
Himachal Pradesh	59655	0	0	192	455	0	330	1966	4001	11943	0	45	40723
Jammu and Kashmir	41884	0	0	224	659	0	0	1693	0	11538	0	0	27770
Punjab	241110	857	0	5679	2939	0	3755	1494	0	80188	122	0	146076
Rajasthan	350312	0	0	5851	9104	0	303	21105	0	130725	56	0	183154
Uttar Pradesh	456260	3654	0	6042	10358	0	3139	24376	0	185142	0	14	223549
Chandigarh	1988	0	0	0	0	0	61	0	0	723	0	0	1176
Delhi	32214	24	0	478	0	0	608	997	0	8475	0	28	21632
Central sector	9382	5385	0	2367	0	0	0	0	0	0	0	0	0
Sub-total	1359072	9920	0	21968	25668	0	9736	55988	4001	482553	178	87	747346
Western region													
Gujarat	315116	1861	0	8086	4273	0	11263	150	5441	112082	0	107	171853
Madhya Pradesh	599295	1953	0	7859	11693	0	362	32745	0	190303	0	49	354331
Maharashtra	479744	5172	0	8731	8170	2817	3264	16780	17553	129581	1369	0	286307
Goa	8601	0	0	24	0	198	0	815	0	2239	0	0	5235
Dadra and Nagar Havek	345	0	0	0	0	0	42	0	0	157	0	0	137
Daman and Diu	1314	0	0	0	0	0	59	0	0	355	0	0	300
Central sector	5930	5076	0	854	0	0	0	0	0	0	0	0	0
Sub-total	1410345	14062	0	25554	24136	3015	14990	50461	22994	431249	1369	156	818853
Southern region													
Andhra Pradesh	614286	0	0	7633	10017	0	633	25782	0	157639	0	34	412511
Karnataka	448955	1023	0	6365	0	5157	4628	5175	0	113674	0	0	312933
Kerala	159796	0	0	1295	0	2444	2565	0	0	24964	0	0	128528
Tamil Nadu	517844	0	5528	0	0	9401	2706	4870	29891	70265	0	0	395183
Lakshadweep	209	0	0	0	0	0	0	0	0	13	0	26	170
Pondicherry	4671	0	0	63	0	158	0	0	616	267	0	0	3567
Central Sector	6218	6154	0	64	0	0	0	0	0	0	0	0	0
Sub-total	1751979	7177	5528	15420	10017	17160	10532	35827	30507	363924	0	60	1252892
Eastern region													
Bihar	180344	583	0	1558	4441	0	0	8876	0	73823	0	0	91063
Orissa	117972	457	0	3467	4211	0	136	9841	0	48401	0	0	51459
West Bengal	158157	292	0	2861	3475	0	806	7365	50	65839	2623	45	74801
Damodar Valley Corporation	5774	0	0	1019	3474	0	0	1281	0	0	0	0	0
Andaman and Nicobar Islands	3298	0	0	0	0	0	0	283	0	817	0	0	2198
Sikkim	4460	0	0	0	0	0	29	0	0	1692	0	4	2735
Central sector	5038	3675	0	1363	0	0	0	0	0	0	0	0	0
Sub-total	475043	5007	0	10268	15601	0	971	27646	50	190068	2623	49	222256
North-eastern region													
Assam	81083	0	0	1044	1357	0	159	4982	0	32831	0	0	40710
Manipur	9849	0	0	0	309	0	0	541	0	4958	0	0	4041
Meghalaya	13681	0	0	0	552	0	0	1038	0	6331	0	0	5760
Nagaland	10675	0	0	0	240	0	236	1874	0	4007	0	0	4318
Tripura	10615	0	0	0	150	0	308	443	0	4261	0	0	5453
Arunachal Pradesh	10521	0	0	0	0	0	0	2832	0	2953	0	0	4736
Mizoram	7092	0	0	0	323	0	110	687	0	3507	0	0	2465
Central sector	1038	0	0	257	781	0	0	0	0	0	0	0	0
Sub-total	144554	0	0	1301	3712	0	813	12397	0	58848	0	0	67483
All-India total	5140993	36166	5528	74511	79134	20175	37042	182348	57552	1533518	4170	352	3108830

[a] Includes union territory also

Source

CEA. 1999. Public Electricity Supply, All India Statistics, General Review, 1993/94,1994/95, and 1996/97. pp.159- 162. New Delhi: Central Electricity Authority. 214 pp

Table 4: State-wise and type-wise electricity generation (MU) during 1997-98

	HYDEL				Thermal				Nuclear		Total
	SEB/Corpn	(%)	PVT.	(%)	SEB/Corpn	(%)	PVT.	(%)		(%)	
I States											
Andhra Pradesh	7641	25.9	0	0	20033	67.8	1874	0	0	0	29548
Assam	0	0	0	0	1074	100	0	0	0	0	1074
Bihar	358	9.8	0	0	3308	90.2	0	0	0	0	3666
Delhi (DVB)	0	0	0	0	2509	100	0	0	0	0	2509
Gujarat	1292	4.2	0	0	23810	77.2	5745	18.6	0	0	30847
Haryana	249	6.6	0	0	3524	93.4	0	0	0	0	3773
Himachal Pradesh	1274	100	0	0	0	0	0	0	0	0	1274
Jammu & Kashmir	907	92.9	0	0	69	7.1	0	0	0	0	976
Karnataka	10753	62.9	61	0.4	6279	36.7	0	0	0	0	17093
Kerala	5034	99.5	26	0.5	0	0	0	0	0	0	5060
Madhya Pradesh	2254	11.2	0	0	17871	88.8	0	0	0	0	20125
Maharashtra	3475	6.4	1284	2.4	37991	70.5	11165	20.7	0	0	53915
Meghalaya	597	100	0	0	0	0	0	0	0	0	597
Orissa	3328	58.1	0	0	2401	41.9	0	0	0	0	5729
Punjab	2721	20.9	0	0	10286	79.1	0	0	0	0	13007
Rajasthan	1461	19	0	0	6233	81	0	0	0	0	7694
Tamil Nadu	5275	22.9	0	0	17804	77.1	0	0	0	0	23079
Uttar Pradesh	5395	22.8	0	0	18295	77.2	0	0	0		23690
West Bengal	290	2	0	0	10250	70.5	3990	27.5	0	0	14530
Sub-total (a)	52304	20.3	1371	0.5	181737	70.4	22774	8.8	0	0	258186
II Eds											
Arunachal Pradesh	13	100	0	0	0	0	0	0	0	0	13
Goa	0	0	0	0	0	0	0	0	0	0	0
Manipur	0	0	0	0	0	0	0	0	0	0	0
Mizoram	0	0	0	0	0	0	0	0	0	0	0
Nagaland	0	0	0	0	0	0	0	0	0	0	0
Pondicherry	0	0	0	0	0	0	0	0	0	0	0
Sikkim	44	100	0	0	0	0	0	0	0	0	44
Tripura	43	14.8	0	0	248	85.2	0	0	0	0	291
Sub total (b)	100	28.7	0	0	248	71.3	0	0	0	0	348
III Central Sector ©	9931	6.6			131274	86.8	0	0	9984	6.6	151189
IV Others (d) *	10682	0	0	0	0	0	0	0	0	0	10682
Grand Total:	73017	17.4	0	0.3	313259	74.5	22774	5.4	9984	2.4	420405

* The share of BBMB for Punjab, Haryana and Rajasthan

Source:

Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Departments, P-55. New Delhi: Power and Energy Division, Government of India.

Table 4a: State-wise and type-wise electricity generation (MU) during 1998-99

	HYDEL				Thermal				Nuclear		Total
	SEB/Corpn	(%)	PVT.	(%)	SEB/Corpn	(%)	PVT.	(%)		(%)	
I States											
Andhra Pradesh	7578	23.7	0	0	21574	67.5	2807	8.8	0	0	31959
Assam	0	0	0	0	945	100	0	0	0	0	945
Bihar	186	4.4	0	0	4052	95.6	0	0	0	0	4238
Delhi (DVB)	0	0	0	0	2069	100	0	0	0	0	2069
Gujarat	1349	3.8	0	0	25017	70.5	9106	25.7	0	0	35472
Haryana	268	7.1	0	0	3485	92.9	0	0	0	0	3753
Himachal Pradesh	1456	100	0	0	0	0	0	0	0	0	1456
Jammu & Kashmir	660	99.1	0	0	6	0.9	0	0	0	0	666
Karnataka	10284	60.3	65	0.4	6707	39.3	0	0	0	0	17056
Kerala	7350	95.8	44	0.6	276	3.6	0	0	0	0	7670
Madhya Pradesh	2813	13.3	0	0	18378	86.7	0	0	0	0	21191
Maharashtra	3689	6.5	1263	2.2	40809	72.1	10873	19.2	0	0	56634
Meghalaya	536	100	0	0	0	0	0	0	0	0	536
Orissa	3409	55	0	0	2789	45	0	0	0	0	6198
Punjab	3489	24.3	0	0	10900	75.8	0	0	0	0	14389
Rajasthan	1293	16	0	0	6770	84	0	0	0	0	8063
Tamil Nadu	4935	22.2	0	0	17263	77.5	73	0.3	0	0	22271
Uttar Pradesh	6138	24.7	0	0	18752	75.3	0	0	0	0	24890
West Bengal	357	2.3	0	0	10446	66.6	4883	31.1	0	0	15868
Sub-total (a)	55790	20.3	1372	0.5	190238	69.1	27742	10.1	0	0	275142
II Eds											
Arunachal Pradesh	16	100	0	0	0	0	0	0	0	0	16
Goa	0	0	0	0	0	0	0	0	0	0	0
Manipur	0	0	0	0	0	0	0	0	0	0	0
Mizoram	0	0	0	0	0	0	0	0	0	0	0
Nagaland	0	0	0	0	0	0	0	0	0	0	0
Pondicherry	0	0	0	0	0	0	0	0	0	0	0
Sikkim	27	100	0	0	0	0	0	0	0	0	27
Tripura	57	16.5	0	0	288	83.5	0	0	0	0	345
Sub total (b)	100	25.8	0	0	288	74.2	0	0	0	0	388
III Central Sector ©	11247	7.1	0	0	135532	85.4	0	0	11987	7.6	158766
IV Others (d) *	14110	100	0	0	0	0	0	0	0	0	14110
Grand Total:	81247	18.1	1372	0.3	326058	72.7	27742	6.2	11987	2.7	448406

* the share of BBMB for Punjab, Haryana and Rajasthan

Source:

Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Departments, P-56.
New Delhi: Power and Energy Division, Government of India.

Table 5 Villages electrified and pumpsets energised in different region and state: 1997 to 1999

Region/state	*Total number of villages (31 March 1997)*	*Total electrified (31 March 1997)*	*Electrified (%) (31 March 1997)*	*Number of villages electrified cumulative in March 1999*	*Number of pumpsets energised cumulative in March 1999*
North					
Haryana	6745	6759	100	6759	410224
Himachal Pradesh	16997	16635	97.9	16635	5392
Jammu and Kashmir	6477	6301	–	6315	5621
Punjab	12428	12428	100	12428	744972
Rajasthan	37889	33554	88.6	34940	590119
Uttar Pradesh	112803	87079	77.2	88641	806270
Chandigarh	25	25	100	0	0
Delhi	199	199	100	0	0
Sub-total	193577	162980	84.2	165718	2562598
West					
Gujarat	18028	17927	99.4	17940	643757
Madhya Pradesh	71526	67496	94.4	68259	1274873
Maharashtra	40412	40412	–	40412	2208738
Goa	360	360	–	360	6590
Daman and Diu	24	24	100	0	0
Dadra and Nagar Haveli	71	71	100	0	0
Sub-total	130421	126290	96.83	126971	4133958
South					
Andhra Pradesh	26586	26565	–	26565	1884571
Karnataka	27066	26663	98.51	26676	1141824
Kerala	1384	1384	100	1384	353405
Tamil Nadu	15822	15822	100	15822	1643915
Lakshadweep	263	263	100	-	-
Pondicherry	7	7	100	-	-
Sub-total	71128	70704	99.4	70447	5023715
East					
Bihar	67513	47832	–	47845	271090
Orissa	46989	32825	69.9	34442	73359
West Bengal	37910	29271	–	29402	107238
Andaman and Nicobar Islan	504	501	–	-	-
Sikkim	447	405	–	405	0
Sub-total	153363	110834	72.3	112094	451687
North-east					
Assam	24685	18999	77	19046	3675
Manipur	2182	1888	86.5	1990	45
Meghalaya	5484	2467	–	2494	65
Nagaland	1216	1153	94.8	1153	176
Tripura	855	788	92.2	806	1764
Arunachal Pradesh	3649	2061	56.5	2215	0
Mizoram	698	672	96.3	684	0
Sub-total	38769	28028	72.3	28388	5725
Total (UTs)					37473
All-India	587258	498836	84.9	504711	12215156

Sources

1 Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Departments. p. 82.
New Delhi: Power and Energy Division, Government of India.

2 CEA. 1999. Public Electricity Supply, All India Statistics, General Review, 1996/97. pp.159-162. New Delhi: Central Electricity Authority. 214 pp

Table 6 Consumer category-wise electricity consumption (MU) during 1998-99

I SEBs	Domestic	Commercial	Agri/irrg	Industry	Rway traction	Outside the state/UT	Others	Total
Andhra Pradesh	6181	1087	9547	7107	905	152	451	25430
Assam	571	217	45	583	0	0	641	2057
Bihar	1052	513	1771	4486	525	160	255	8762
Delhi (DVB)	3460	534	96	3543	0	0	0	7633
Gujarat	2663	764	11865	10607	370	3127	0	29396
Haryana	1837	320	3876	2101	116	80	914	9244
Himachal Pradesh	525	150	12	1312	0	610	161	2770
Jammu & Kashmir	658	136	488	362	0	259	780	2683
Karnataka	3272	563	8862	3502	28	0	982	17209
Kerala	4480	784	410	3190	10	0	341	9215
Madhya Pradesh	4375	707	9926	5290	1366	184	3622	25470
Maharashtra	5822	1321	16013	15818	1004	1250	6732	47960
Meghalaya	125	41	2	61	0	142	107	478
Orissa	2174	353	200	2989	180	0	483	6379
Punjab	3606	769	6175	7721	0	1022	535	19828
Rajasthan	2654	844	6032	5298	180	437	902	16347
Tamil Nadu	4388	1950	7450	11273	445	305	1890	27701
Uttar Pradesh	8111	2229	9337	6490	1048	475	1284	28974
West Bengal	2206	1009	1624	2871	513	19	2241	10483
Sub-total (a)	58160	14291	93731	94604	6690	8222	22321	298019
II Eds								
Arunachal Pradesh	69	8	0	10	0	0	12	99
Goa	261	15	13	663	0	42	170	1164
Manipur	168	19	10	52	0	0	78	327
Mizoram	85	8	0	1	0	0	12	106
Nagaland	74	9	0	20	0	0	26	129
Pondicherry	156	56	96	726	0	0	25	1059
Sikkim	49	18	0	15	0	0	16	98
Tripura	139	36	79	52	0	52	91	449
Sub total (b)	1001	169	198	1539	0	94	430	3431
Grand Total	59161	14460	93929	96143	6690	8316	22751	301450

Source:

Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Departments, P-74. New Delhi. Power and Energy Division, Government of India.

Table 6a Consumer category-wise electricity consumption (MU) during 1998-99

I SEBs	Domestic	Commercial	Agri/irrig	Industry	R.way traction	Outside the state/	Others	Total
Andhra Pradesh	6958	1200	10050	7734	1150	155	491	27738
Assam	578	249	44	609	0	0	696	2176
Bihar	1162	567	1956	4957	579	176	804	10201
Delhi (DVB)	3996	616	111	4082	0	0	0	8805
Gujarat	2893	866	12870	11412	385	3480	0	31906
Haryana	1951	340	4000	2268	123	85	949	9716
Himachal Pradesh	585	165	14	1459	0	757	177	3157
Jammu & Kashmir	800	169	586	455	0	310	843	3163
Karnataka	3646	596	10198	5349	31	0	954	20774
Kerala	5544	971	507	3948	13	0	422	11405
Madhya Pradesh	4733	723	10160	4872	1485	184	3845	26002
Maharashtra	6348	1453	16682	17151	1100	3000	6905	52639
Meghalaya	128	43	2	67	0	130	110	480
Orissa	2242	433	231	4749	236	0	563	8454
Punjab	3990	850	6300	8541	0	1130	577	21388
Rajasthan	2868	985	5763	6594	236	400	815	17661
Tamil Nadu	4638	2303	7762	11973	421	318	1479	28894
Uttar Pradesh	9388	2531	9593	6634	1160	475	1327	31108
West Bengal	2368	1084	1742	3080	550	21	1991	10836
Sub-total (a)	64816	16144	98571	105934	7469	10621	22948	326503
II Eds								0
Arunachal Pradesh	69	11	0	13	0	0	12	105
Goa	280	17	14	800	0	42	203	1356
Manipur	183	21	11	56	0	0	65	336
Mizoram	78	9	0	1	0	0	14	102
Nagaland	80	9	0	21	0	0	28	138
Pondicherry	182	61	120	787	0	0	30	[illegible]
Sikkim	53	20	0	19	0	0	18	110
Tripura	169	41	87	60	0	52	101	510
Sub total (b)	1094	189	232	1757	0	94	471	3837
Grand total	65910	16333	98803	107691	7469	10715	23419	330340

Source:

Planning Commission. 2000 Annual Report on the Working of State Electricity Boards and Electricity Departments, P-75. New Delhi. Power and Energy Division, Government of India.

Table 1: Region wise potential and development - Hydro as on 31st March 1996

Region	Hydroelectric potential at 60% load factor	under development (equivalent to 60% load factor)	Hydroelectric potential developed (equivalent to 60% load factor)
North	30,155	2,204.6 (7.3)	4,138.2 (13.7)
West	5,679	1,536.1 (27.1)	1,818.8 (32.0)
South	10,763	1,108.2 (10.3)	5,293.8 (49.2)
East	5,590	720.0 (12.9)	908.8 (16.3)
North-east	31,857	309.9 (1.0)	315.5 (1.0)
All-India total	84,044	5,878.8 (7.0)	12,475.1 (14.8)

Note

Figures in parentheses indicate percentages.

Source

CEA. 1999. Review of Performance of Hydro Power Stations, 1995/96 p. 1. New Delhi: Hydro Electric Development Potential Directorate, Hydro Wing, Central Electricity Authority. 172 pp.

Table 2A: State wise Power Supply position, 1999-2000

	Peak in MW				Energy in MU			
	Peak demand	Peak met	Surplus(+)/Shrotage(-) MW	%	Energy requirement	Energy met	Surplus(+)/Shrotage(-) MU	%
Chandigarh	180	180	0	0	1033	1032	-1	-0.1
Delhi	2850	2498	-352	-12.4	17635	17141	-494	-2.8
Haryana	2527	2527	0	0	15950	15578	-372	-2.3
Himachal Pradesh	618	618	0	0	3125	3115	-10	-0.3
Jammu and Kashmir	1210	1004	-206	-17.0	6065	4903	-1162	-19.2
Punjab	5029	5029	0	0	26335	26164	-171	-0.6
Rajasthan	3672	3672	0	0	25155	24024	-1131	-4.5
Uttar Pradesh	6580	5058	-1522	-23.1	44525	38800	-5725	-12.9
Northern Region Total	20980	18882	-2098	-10.0	139823	130743	-9066	-6.5
Gujarat	7554	5962	-1592	-21.1	51202	46994	-4208	-8.2
Madhya Pradesh	6836	4808	-2028	-29.7	37198	34543	-2655	-7.1
Maharashtra	12075	9747	-2328	-19.3	73498	69002	-4496	-6.1
Goa	260	234	-26	-10.0	1806	1414	-392	-21.7
Western Region Total	24864	20333	-4531	-18.2	163704	151953	-11751	-7.2
Andhra Pradesh	7209	6366	-843	-11.7	45835	42832	-3003	-6.6
Karnataka	4591	3881	-710	-15.5	28201	25851	-2350	-8.3
Kerala	2386	2169	-217	-9.1	12850	11908	-942	-7.3
Tamil Nadu	6446	5640	-806	-12.5	38873	35797	-3076	-7.9
Southern Region Total	20424	17832	-2592	-12.7	125759	116388	-9371	-7.5
Bihar	1430	1201	-229	-16.0	8912	8348	-564	-6.3
DVC	1276	1276	0	0	8464	8668	204	2.4
Orissa	1909	1809	-100	-5.2	10838	11143	305	2.8
West Bengal	3217	3010	-207	-6.4	17951	18298	347	1.9
Eastern Region Total	7370	7012	-358	-4.9	46165	46457	292	0.6
Arunachal Pradesh	48	45	-3	-6.3	119.8	120.7	0.9	0.8
Assam	565	556	-9	-1.6	2868.3	2918.4	50.1	1.7
Manipur	99	95	-4	-4.0	470.5	451.2	-19.3	-4.1
Meghalaya	124	126	2	1.6	514.1	540.8	26.7	5.2
Mizoram	64	64	0	0	220.8	223.9	3.1	1.4
Nagaland	49	48	-1	-2.0	205.6	207.8	2.2	1.1
Tripura	126	98	-28	-22.2	579.9	590.1	10.2	1.8
North Eastern Total	959	932	-27	-2.8	4979	5052.9	73.9	1.5
All India	72669	63691	-8978	-12.4	480430	450594	-29836	-6.2

Source: CEA

	Peak in MW				Energy in MU			
	Peak demand	Peak met	Surplus(+)/Shrotage(-) MW	%	Energy requirement	Energy met	Surplus(+)/Shrotage(-) MU	%
Chandigarh	197	197	0	0	1025	1022	-1	-0.1
Delhi	2703	2484	-219	-8.1	16500	16184	-494	-3.0
Haryana	2416	2215	-201	-8	14106	13808	-372	-2.6
Himachal Pradesh	585	585	0	0	2954	2949	-10	-0.3
Jammu and Kashmir	1150	941	-209	-18.2	5784	5437	-1162	-20.1
Punjab	4451	4451	0	0	24884	24340	-171	-0.7
Rajasthan	3651	3498	-153	-4	23340	22766	-1131	-4.8
Uttar Pradesh	6642	5328	-1314	-19.8	42291	38138	-5725	-13.5
Northern Region Total	19789	17876	-1913	-9.7	130884	124644	-9066	-6.9
Gujarat	7018	5877	-1141	-16.3	45685	42835	-2850	-6.2
Madhya Pradesh	6375	4770	-1605	-25.2	35407	33345	-2062	-5.8
Maharashtra	10665	8675	-1990	-18.7	66332	63778	-2554	-3.9
Goa	260	210	-50	-19.2	1650	1445	-205	-12.4
Western Region Total	23014	18082	-4932	-21.4	149074	141403	-7671	-5.1
Andhra Pradesh	6770	6139	-631	-9.3	41958	38293	-3665	-8.7
Karnataka	4411	3726	-685	-15.5	26061	22626	-3435	-13.2
Kerala	2136	1889	-247	-11.6	12313	11114	-1199	-9.7
Tamil Nadu	5950	5190	-760	-12.8	37706	33268	-4438	-11.8
Southern Region Total	18812	16490	-2322	-12.3	118038	105301	-12737	-10.8
Bihar	1347	1139	-208	-15.4	8668	7965	-703	-8.1
DVC	1289	1233	-56	-4	7921	8226	305	3.9
Orissa	1854	1816	-38	-2.0	10757	11115	358	3 3
West Bengal	2981	2808	-173	-5.8	16319	16778	459	2.8
Eastern Region Total	7111	6475	-636	-8.9	43665	44084	419	1.0
Arunachal Pradesh	44	43	-1	-2.3	123	113	-10.7	-8.7
Assam	531	514	-17	-3.2	2876	2799	-77	-2.7
Manipur	98	95	-3	-3.1	506	501	-5.3	-1.0
Meghalaya	100	101	1	1.0	435	460	25	5.7
Mizoram	58	55	-3	-5	204	193	-11	-5.4
Nagaland	42	35	-7	-16.7	197	187	-10	-5.1
Tripura	115	90	-25	-21.7	581	550	-31	-5.3
North Eastern Total	915	862	-53	-5.8	4923	4803	-120	-2.4
All India	67905	58445	-9460	-13.9	446584	420235	-26349	-5.9

Source: CEA

Table 3: Annual Plant Load Factor (%) of thermal stations, 1996-97 to 1998-99

Agency	1996/97	1997/98	1998/99
State electricity board			
Northern region	64.7	66.7	67.2
Haryana	47.7	49.4	48.8
Punjab	65.7	69.1	69.2
Rajasthan	75.6	80.5	78.9
Uttar Pradesh	49.1	48.8	48.8
Western region	70.2	70.3	70.7
Gujarat	64.8	65.6	63.2
Maharashtra	68.7	68.3	68.3
Madhya Pradesh	62.3	66	67.8
Southern region	75.8	77.1	75.4
Andhra Pradesh	78.3	82	76.9
Tamil Nadu	72.3	68.1	65.9
Karnataka	70.2	75.2	81.7
Eastern region	42.2	43	44.1
Bihar	15.3	16.1	22.6
Orissa	69.4	65.3	75.8
West Bengal	39.2	40	36.7
North-eastern region	27.1	21.3	18.8
Assam	27.1	21.3	18.8
Total	60.3	60.9	60.7
Central sector	71	70.4	71.1
National Thermal Power Corporatio	76.4	74.4	75.6
Neyveli Lignite Corporation	70.3	72.5	73.7
Damodhar Valley Corporation	35.6	38.4	38.1
Durgapur Power Limited	29.5	25.3	-
Delhi Vidyut Board	41.7	47.2	38.3
West Bengal Power Development C	56.5	52.8	59.7
Private sector	71.2	71.1	68
Ahmedabad Electric Company Limi	71.4	71.3	74.5
Trombay	68.8	63.5	61
Calcutta Electricity Supply Compan	74.9	76.9	71.6
All-India	64.4	64.7	64.6

Source

Planning Commission. 2000. **Annual Report on the Working of State Electricity Boards and Electricity Departments.** New Delhi: Power and Energy Division, Planning Commission, Government of India.

Table 4: Auxiliary Consumption (%), 1998-99 & 1999-2000
(Weighted average of thermal & Hydel plants for all state sector)

SEBs	Auxiliary Consumption (%) 1998-99	1999-2000
Andhra Pradesh	6.85	6.67
Assam	6.24	6.97
Bihar	14.33	14.17
Delhi (DVB)	8.62	7.90
Gujarat	9.43	9.44
Haryana (HPGC)	11.58	10.77
Himachal Pradesh	0.29	0.39
Jammu & Kashmir	1.00	1.00
Karnataka	2.42	2.49
KPCL	3.88	4.37
Kerala	0.77	1.29
Madhya Pradesh	8.78	8.77
Maharashtra	7.50	7.86
Meghalaya	0.40	0.40
Orissa (OHPC)	1.00	1.00
OPGC	10.24	12.64
Punjab	5.06	5.04
Rajasthan	7.31	7.70
Tamil Nadu	7.26	7.16
Uttar Pradesh	7.30	7.17
West Bengal SEB	11.04	11.00
WBPDC	9.66	9.64
Average	7.13	7.12

Source

Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Dep
New Delhi: Power and Energy Division, Planning Commission, Government of India.

Table 5: Fuel consumption by coal based thermal units, 1998-99 & 1999-2000

SEBs	Coal (kg / kWh of generation) 1998-99	1999-2000
Andhra Pradesh	0.76	0.77
Assam	0.67	0.67
Bihar	0.93	0.93
Delhi (DVB)	0.83	0.83
Gujarat	0.76	0.81
Haryana	0.85	0.84
Himachal Pradesh	0.00	0.00
Jammu & Kashmir	0.00	0.00
Kamataka (KPCL)	0.73	0.73
Kerala	0.00	0.00
Madhya Pradesh	0.78	0.78
Maharashtra	0.79	0.79
Meghalaya	0.00	0.00
Onssa (OPGC)	0.89	0.89
Punjab	0.69	0.69
Rajasthan	0.70	0.71
Tamil Nadu	0.75	0.77
Uttar Pradesh	0.80	0.80
West Bengal SEB	0.62	0.62
WBPDC	0.75	0.75
Average	0.77	0.78

Source

Planning Commission. 2000 **Annual Report on the Working of State Electricity Boards and Electricity Departments.** New Delhi: Power and Energy Division, Planning Commission, Government of India.

Table 6: Secondary Oil consumption in coal based thermal units, 1998-99 & 1999-2000

	Oil (ml/kWh generation)	
SEBs	1998-99	1999-2000
Andhra Pradesh	2.27	2.38
Assam	54.00	45.00
Bihar	25.29	25.24
Delhi (DVB)	18.53	17.14
Gujarat	6.79	6.90
Haryana	15.53	13.68
Himachal Pradesh	0.00	0.00
Jammu & Kashmir	0.00	0.00
Karnataka (KPC)	0.00	0.00
Kerala	0.77	0.00
Madhya Pradesh	0.00	3.62
Maharashtra	3.47	2.80
Meghalaya	0.00	0.00
Orissa (OPGC)	1.88	0.00
Punjab	2.23	2.39
Rajasthan	3.00	3.00
Tamil Nadu	8.32	5.99
Uttar Pradesh	5.80	5.92
West Bengal SEB	6.42	7.26
WBPDC	6.00	4.00
Average	5.38	6.00

Source

Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Departments. New Delhi: Power and Energy Division, Planning Commission, Government of India.

Table 7: Transmission and distribution losses 1998/99 to 1999/2000

State	1998/99	1999/2000
Andhra Pradesh	31.9	31.1
Arunachal Pradesh	31.1	31.5
Assam	23.0	30.0
Bihar	39.5	36.0
Daman and Diu	0	0
Goa	29.1	23.0
Gujarat	20.1	18.0
Haryana	29.6	29.5
Himachal Pradesh	18.5	18.1
Jammu and Kashmir	43.8	46.5
Karnataka	17	18.3
Kerala	17.5	17.0
Lakshadweep	0	0
Madhya Pradesh	17.8	18.6
Maharashtra	17.3	17.0
Manipur	19.7	20.0
Meghalaya	18.9	19.0
Mizoram	42.0	43.0
Nagaland	29.0	28.5
Orissa	42.0	36.0
Punjab	17.1	17.7
Rajasthan	29.5	22.0
Sikkim	20.0	19.8
Tamil Nadu	16.6	16.5
Tripura	28.5	28.0
Uttar Pradesh	26.3	22.9
West Bengal	19.5	19.0
All-India (utilities)	23.2	22.0

Source

Planning Commission. 2000. **Annual Report on the Working of State Electricity Boards and Electricity Departments.** New Delhi: Power and Energy Division, Planning Commission, Government of India.

Table 8: Industry wise Captive Power Plants capacity (MW), net generation and energy sold (MU)

		Installed capacity (kW) as on 31 March 1997						Energy (MU) as on 31 March 1997		
Industry	No. of factories	Hydro	Steam	Diesel	Gas	Wind	Total	Energy cosn. in station auxiliaries	Net Generation	Energy sold to utilities
Aluminium (primary)	4	0	1408500	0	0	0	1408500	991.98	9136.13	928 13
Aluminium (secondary)	8	0	62000	8824	0	0	70824	82.96	198.9	0
Automobile	29	0	0	124825	40000	0	164825	3 03	303.13	92 4
Cement (primary)	87	0	318000	726312	0	0	1044312	164.68	2403.12	0
Cement (secondary)	15	0	0	42783	0	0	42783	0.85	36.97	0
Chemicals	169	0	426870	452544	50500	24450	954364	235.8	2331.4	0
Colliery	8	0	103400	6000	0	0	109400	31.97	217.73	0
Electrical engineering	63	0	15000	143552	6000	0	164552	8.43	128.6	0
Fertilizer	39	0	578750	91769	389560	0	1060079	332.74	3673.53	35.31
Food product	56	0	3200	101987	2800	2025	110012	1.48	64.39	0
Heavy engineering	41	0	0	165671	0	13400	179071	4.57	123.77	0
Iron and steel (primary)	16	0	1343900	60416	24000	0	1428316	1157.55	5737.06	279.51
Iron and steel (secondary)	58	0	3000	151065	20200	0	174265	7.83	248.84	0
Jute	64	0	0	168999	0	0	168999	3.58	106.65	0
Light engineering	86	0	1500	206069	0	0	207569	2.27	119.77	0
Mineral oil and petroleum	21	0	322150	109587	352822	15315	799874	237.93	3040.23	129 39
Mining and quarrying	7	0	8400	29550	0	0	37950	0.62	18.85	0
Miscellaneous	103	0	35300	250762	145000	0	431062	39.91	1309.07	353.53
Non-ferrous	26	0	116800	266816	20000	0	403616	59.46	1172.94	56 18
Paper	51	0	442235	73347	0	0	515582	219.58	1747.89	0
Plastic	1	0	0	0	12500	0	12500	1.89	35.99	0
Rubber	28	0	14600	118677	0	0	133277	9.01	204	0
Sugar	228	0	707712	81025	0	0	788737	105.72	1626.38	1.9
Textile	432	3500	240370	1149325	103000	9650	1505845	146.7	2979.13	0
Total	1,640	3500	6151687	4529905	1166382	64840	11916314	3850.54	36964.47	1876.35

Source

CEA General Review, 1996-97

Table 9: Captive power plants number and capacity (KW) statewise and fuel wise as on 31.3 .97

State	No. of industries	Installed capacity (MW)					
		Hydro	Steam	Diesel	Gas	Wind	Total
Haryana	80	0	68890	238532	40000	0	347422
Himachal Pradesh	17	0	0	70220	0	0	70220
Jammu& Kashmir	2	0	0	2732	0	0	2732
Punjab	85	0	69190	190144	0	0	259334
Rajasthan	72	0	141280	370491	55320	0	567091
Uttar Pradesh	220	0	741427	347325	179000	0	1267752
Chandigarh	2	0	0	5755	0	0	5755
Delhi	7	0	39500	8176	0	0	47676
Northern Region Total	485	0	1060287	1233375	274320	0	2567982
Gujarat	144	0	479910	351963	515920	16315	1364108
Madhya Pradesh	97	0	658350	446826	34450	0	1139626
Maharashtra	177	0	251265	318335	98322	0	667922
Goa	3	0	7500	5272	0	0	12772
Daman &Diu	0	0	0	0	0	0	0
D&N Haveli	5	0	0	16936	0	0	16936
Western Region Total	426	0	1397025	1139332	648692	16315	3201364
Andhra Pradesh	125	0	615810	483529	61380	2000	1162719
Karnataka	86	3500	247215	346100	0	0	596815
Kerala	35	0	63650	73910	22000	0	159560
Tamil Nadu	268	0	293775	572614	17140	46525	930054
Pondicherry	7	0	5000	10036	0	0	15036
Lakshadweep	0	0	0	0	0	0	0
Southern Region Total	521	3500	1225450	1486189	100520	48525	2864184
Bihar	41	0	743650	193918	2500	0	940068
Orissa	32	0	1284600	134345	36300	0	1455245
West Bengal	119	0	320975	265115	21150	0	607240
A& N Islands	1	0	0	1308	0	0	1308
Sikkim	0	0	0	0	0	0	0
Eastern Region Total	193	0	2349225	594686	0	0	2943911
Assam	13	0	110200	76323	82900	0	269423
Manipur	0	0	0	0	0	0	0
Meghalaya	0	0	0	0	0	0	0
Nagaland	2	0	9500	0	0	0	9500
Tripura	0	0	0	0	0	0	0
Arunachal Pradesh	0	0	0	0	0	0	0
Mizoram	0	0	0	0	0	0	0
North-Eastern Region total	15	0	119700	76323	82900	0	278923
All India	1640	3500	6151687	4529905	1166382	64840	11916314

Source:

CEA General Review 1996-97

Table 10: Consumer categorywise average tariff of electricity (paise/kWh): 1998/1999

State electricity board / Agency	Domestic	Commercial	Agriculture/irrigation	Industrial	Railway traction	Outside state	Overall average
Andhra Pradesh	165.6	369.0	16.9	360.0	378.0	36.7	173.6
Assam	146.8	4.0	161.4	233.3	0.0	0.0	250.1
Bihar	109.4	297.9	12.2	275.3	330.0	190.6	200.1
Delhi	255.0	223.2	116.0	299.4	0.0	0.0	270.7
Gujarat	197.0	237.0	18.0	370.8	435.0	0.0	203.0
Haryana	260.0	363.0	55.0	372.7	372.6	138.0	203.4
Himachal Pradesh	60.0	372.7	50.0	210.0	0.0	180.0	178.2
Jammu and Kashmir	51.0	230.0	60.0	66.0	0.0	0.0	71.0
Karnataka	179.0	92.0	14.9	396.5	348.5	0.0	166.9
Kerala	83.4	591.2	54.6	180.3	112.7	0.0	135.8
Madhya Pradesh	74.5	309.1	6.3	376.7	532.3	151.9	161.5
Maharashtra	158.0	362.4	30.0	390.0	390.0	230.0	223.1
Meghalaya	84.2	459.3	50.0	151.9	0.0	179.7	134.2
Orissa	165.2	159.8	89.0	311.8	356.7	0.0	254.4
Punjab	168.9	316.2	-	268.9	0.0	200.0	165.0
Rajasthan	137.0	311.2	36.5	318.9	328.0	221.6	194.4
Tamil Nadu	148.1	307.0	0.0	322.9	322.9	80.9	199.3
Uttar Pradesh	105.0	358.8	48.6	418.5	449.4	16.0	187.0
West Bengal	82.0	303.8	20.2	277.7	291.0	279.8	193.8
Average	141.8	175.7	22.1	340.4	411.0	100.7	192.9

Source

Planning Commission. 2000. Annual Report on the Working of State Electricity Boards and Electricity Departments. New Delhi. Power and Energy Division, Planning Commission, Government of India.

Table 10A: Consumer categorywise average tariff of electricity (paise/kWh): 1999/2000

State electricity board / Agency	Domestic	Commercial	Agriculture/irrigation	Industrial	Railway traction	Outside state	Overall average
Andhra Pradesh	165.6	369.0	16.5	370.0	378.0	36.7	181.0
Assam	147.5	299.2	159.3	233.7	0	0	290.0
Bihar	109.4	223.2	12.2	275.3	330.0	190.6	200.1
Delhi	270.0	2347.9	120.0	313.5	0	0	282.7
Gujarat	237.0	404.0	18.0	410.7	475.0	0	227.0
Haryana	272.0	392.0	55.0	392.0	392.0	138.0	214.8
Himachal Pradesh	65.0	235.0	50.0	216.3	0	190.0	185.1
Jammu and Kashmir	125.0	220.0	240.0	135.0	0	0	200.0
Kamataka	201.2	657.1	14.9	436.1	394.5	0	184.7
Kerala	83.4	340.1	54.6	198.3	123.9	0	190.0
Madhya Pradesh	74.5	362.4	6.3	374.5	532.3	151.9	156.3
Maharashtra	164.0	480.0	39.0	202.3	415.0	230.0	233.6
Meghalaya	130.0	181.0	50.0	203.3	0	180.6	167.1
Onssa	180.2	347.3	95.7	306.9	362.3	0	271.0
Punjab	177.0	326.2	0	280.2	0	200.0	175.9
Rajasthan	138.0	310.0	34.9	321.9	331.0	221.9	195.8
Tamil Nadu	162.2	390.6	0.0	375.7	375.7	81.7	228.1
Uttar Pradesh	105.0	303.8	48.5	418.4	449.6	16.0	185.6
West Bengal	100.5	215.4	28.1	309.3	323.2	310.6	217.0
Average	149.7	353.9	24.8	350.5	410.6	121.7	207.8

Source

Planning Commission. 2000. **Annual Report on the Working of State Electricity Boards and Electricity Departments.**
New Delhi: Power and Energy Division, Planning Commission, Government of India.

Renewable energy sources

Table: Sources of supply of wood fuels in 1991 in India

Source	Details	Total fuel wood contribution in mtonnes/year
Forest	Felling of trees	19
	Lopping of twigs and branches	42
	Logging wastes	9 5
Shrubs on degraded lands and roadsides		46
Tree planting on 17 m ha during 1975-1990 through social and farm forestry programmes	Tops, twigs small branches and poles	40
Homestead gardens	Twigs and branches	16
Total		172.5

Table: Fuel wood consumption and supply projections for India

Consumption	1994			2010		
	Area	Mass	Energy	Area	Mass	Energy
	1000 ha	Kton	PJ	1000ha	Kton	PJ
Total woodfuels		173412	2601		225725	3386
Potential Supply						
Sustainable woodfuel from forest land	64996	85695	1285	65363	98313	1475
Sustainable woodfuel from agricultural areas	189805	125323	1880	195235	138132	2072
Sustainable woodfuel from other wooded lands	8884	5100	77	3454	2002	30
Waste woodfuels from deforestation	-269	18999	285	-244	17280	259
Total potentially available woodfuels	263416	235167	3528	263808	255729	3836
50% of crop processing residues	189805	70267	1143	195235	106319	1759
Total potentially available biomass fuels		305434	4670		362048	5594

Area = 89% of geographical land area

Table: Annual availability of fuelwood from the forests of India (000 cum)

States	Fuelwood
Andhra Pradesh	1779
Arunachal Pradesh	4573
Assam	1818
Bihar	514
Goa, Daman, & Diu	70
Gujarat	438
Haryana	9
Himachal Pradesh	482
Jammu and Kashmir	1921
Karnataka	1672
Kerala	595
Madhya Pradesh	4237
Maharashtra	1503
Manipur	566
Meghalaya	646
Mizoram	399
Nagaland	571
Orissa	1370
Punjab	6
Rajasthan	87
Sikkim	230
Tamil Nadu	418
Tripura	95
Uttar Pradesh	1746
West Bengal	130
Andaman & Nicobar	449
Dadra & Nagar Haveli	6
Total	26290

Of this 26.3 million cum, nearly 20 percent will not become available as it lies in protected areas or due to remoteness etc. In this way about 17 million tonnes of fuelwood is available from the forest of India every year on sustained basis.

Source: Forest Survey of India (1995)

Potential of bagasse cogeneration in India

Table: Statewise sectoral break-up of sugar mills in India

State	Joint sector	Public sector	Co-op.sector	Total
Uttar Pradesh	44	35	31	110
Maharashtra	5	-	104	109
Andhra Pradesh	10	8	18	36
Tamil Nadu	14	3	15	32
Karnataka	11	3	17	31
Bihar	14	15	-	29
Gujarat	-		19	19
Punjab	4	-	15	19
Haryana	1	-	10	11
Orissa	7	-	1	8
Madhya Pradesh	2	3	3	8
Kerala	1	-	2	3
Rajasthan	1	1	1	3
Assam	1	1	1	3
West Bengal	1	1	-	2
Pondicherry	1	-	1	2
Nagaland		1	-	1
Goa	-	-	1	1
Total	117	71	239	427

Potential of bagasse cogeneration in India

Table: Capacity wise break-up of sugar mills in Indian states

State	<1250 TCD	<2500 TCD	>2500 TCD	<5000 TCD	>5000 TCD	Total TCD
Uttar Pradesh	44	18	29	12	7	110
Maharashtra	44	18	26	15	6	109
Andhra Pradesh	22	4	6	1	3	36
Tamil Nadu	6	7	13	4	2	32
Karnataka	15	5	6	1	4	31
Bihar	15	10	3	0	1	29
Gujarat	7	1	4	3	4	19
Punjab	6	2	9	1	1	19
Haryana	5	2	3	0	1	11
Orissa	5	0	3	0	0	8
Madhya Pradesh	7	1	0	0	0	8
Kerala	3	0	0	0	0	3
Rajasthan	2	1	0	0	0	3
Assam	2	0	0	0	0	3
West Bengal	2	0	0	0	0	2
Pondicherry	1	1	0	0	0	2
Nagaland	1	0	0	0	0	1
Goa	1	0	0	0	0	1
Total	189	70	102	37	29	427

Table: State-wise potential sites for windfarms

SL.NO.	STATE	NO. OF POTENTIAL SITES
1	Andhra Pradesh	29
2	Andaman & Nicobar	1
3	Gujarat	32
4	Kamataka	24
5	Kerala	14
6	Lkashdweep	8
7	Madhya Pradesh	7
8	Maharashtra	21
9	Orissa	6
10	Rajasthan	8
11	Tamil Nadu	39
12	West Bengal	2
13	Uttar Pradesh	1
	Total	192

Table: Cumulative state-wise achievement up to 31st March, 2000 and estimated potential

State/U.T.	No. of Chulhas in lakhs		% coverage of potential
	Estimated Potential	Cumulative Achievement	
Andhra Pradesh	97.08	36.71	38
Arunachal Pradesh	1.5	0.38	25
Assam	36	5.63	16
Bihar	123.83	11.74	9
Gujarat	50.72	13.52	27
Goa	1.17	1.16	99
Haryana	20.61	9.87	48
Himachal Pradesh	8.53	6.62	78
Jammu & Kashmir	11.75	4.15	35
Karnataka	60.76	15.36	25
Kerala	40.73	8.67	21
Madhya Pradesh	101.58	29.27	29
Maharashtra	96.5	23.21	24
Manipur	2.64	0.65	25
Meghalaya	2.54	0.2	8
Mizoram	0.73	0.47	64
Nagaland	2.01	0.3	15
Orissa	54.55	18.08	33
Punjab	25.38	11.07	44
Rajasthan	55.54	25.45	46
Sikkim	0.73	0.68	93
Tamil Nadu	80.16	26.43	33
Tripura	4.65	0.53	11
Uttar Pradesh	187.45	37.42	20
West Bengal	98.72	30.89	31
Andaman & Nicobar	0.4	0.31	78
Chandigarh	0.66	0.19	29
Dadra & Nagar Haveli	0.25	0.13	52
Daman & Diu	0.1	0.01	10
Delhi	9.06	2.66	29
Lakshwadeep	0.1	0.05	50
Pondicherry	0.59	0.35	59
Total	1200	322.16	27

Table: Identified small hydro potential sites in India (up to 3 MW)

Sl.No.	Name of State	Identified Sites up to 3 MW
1	Haryana	21
2	Himachal Pradesh	166
3	Jammu & Kashmir	106
4	Punjab	78
5	Rajasthan	49
6	Uttar Pradesh	310
7	Gujarat	283
8	Madhya Pradesh	99
9	Maharashtra	183
10	Andhra Pradesh	271
11	Karnataka	181
12	Kerala	167
13	Tamilnadu	131
14	Bihar	158
15	Orissa	152
16	Sikkim	52
17	West Bengal	141
18	Arunachal Pradesh	433
19	Assam	38
20	Manipur	91
21	Meghalaya	83
22	Mizoram	73
23	Nagaland	67
24	Tripura	8
25	A&N Island	5
26	Goa	3
	Total	3349

Table: Potential for bagasse based co-generation in major sugar producing states in india.

STATE	POTENTIAL in MW
MAHARASHTRA	1000
UTTAR PRADESH	1000
TAMIL NADU	350
KARNATAKA	300
ANDHRA PRADESH	200
BIHAR	200
GUJARAT	200
PUNJAB	150
OTHERS	100
TOTAL	3500

Table: State-wise List of Commissioned Biomass Power Projects
(In MW)

Sl.No.	STATE	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	Total Capacity
1	Andhra Pradesh	--	--	--	--	1	--	10	1	12
2	Gujarat	--	--	--	--	--	--	0.5	--	0.5
3	Haryana	4	--	--	--	--	--	--	--	4
4	Karnataka	--	--	--	--	1	--	10	26	37
5	Maharashtra	1.5	--	1.5	4.5	1.5	--	--	--	9
6	Madhya Pradesh	--	--	--	--	--	--	5	--	5
7	Punjab	--	10	--	--	--	--	--	--	10
8	Tamil Nadu	3	3	4	19	25.5	33.5	10	--	98
9	Uttar Pradesh	--	--	--	6.5	--	8	8	24	46.5
		8.5	13	5.5	30	29	41.5	43.5	51	222

Table: Chemical characteristics of city refuse

Parameter	Population of city (million)			
	< 0.2	0.2-0.5	0.5-2.0	> 2.0
Moisture(%)	22.1	25.1	22.4	31.2
pH (%)	8.2	8.2	8.3	7.7
* Organic matter (%)	22	22.5	21.5	27.6
* Carbon (%)	12.3	12.6	12	15.3
* Nitrogen (%)	0.6	0.6	0.6	0.6
* Phosphorus pentoxide (%)	0.7	0.7	0.7	0.6
* Potash (%)	0.7	0.7	0.7	0.7
Calorific value (kcal/kg)	**801**	**874**	**867**	**1140**

* on a dry weight basis

Table: Urban population (million); potential availability (MTPA -million tonnes per annum) of city refuse: 1971-91

Item	1971	1981	1991
Urban population (million)	109.1	159.5	217.6
City refuse (MTPA)			
Non-compostable (60%)	9.6	14	19.1
Compostable (40%)	6.4	9.3	12.7
Total	**16**	23.3	31.8

Note: city refuse is equal to urban population x 0.4 kg urban dweller per day x 365 days

Renewable Energy and Government Structure

Though renewable energy technologies (RETs) such as biogas plants and improved cook stoves had been available in India since the late 1940s, the program itself was initiated on a very moderate scale in the wake of the energy crisis of 1973. Government of India set up a high-powered CASE **(Commission for Additional Sources of Energy)** to draw up plans for achieving a harmonious transition from an economy based on hydrocarbons to one based on renewable energy resources. To provide focussed attention to this sector, a separate Department of Non-conventional Energy Sources was also created in 1982, under the Ministry of Energy, at par with Departments of Coal and Power. After a decade, in 1992, the Department was upgraded to the status of a Ministry, named the **MNES (Ministry of Non-conventional Energy Sources)** to increase the deployment of renewable energy technologies. Following table provides a brief history of RE sector governance and policy initiatives:

Table: RE sector governance and policy initiatives

Year/Period	Department	Action
1970	FPC recommendation	RE sources first recognised and incorporated in an official policy document
1970s	Following oil-shock	RE policy and planning received a further push for increased R&D and promotional efforts
5th five year plan		National project for biogas development (NPBD) launched target set for establishing 1.5 million plants by 2001
6th five year plan		Official emphasis on RE sources on a permanent footing separate heading for new and renewable sources of energy (NRSE)
1981		RE became an integral part of the Prime Minister's 20 point programme. Commission of Additional Sources of Energy was created (CASE)
1982	Establishment of DNES	Department of Non-conventional energy sources (DNES), an exclusive administration unit under the Ministry of Energy
7th five year plan		A national level programme on social forestry and improved cooking was launched in addition to the planning of the 6th plan. Mass demonstrations and experimentations on other renewable sources like wind, solar, biomass, tidal etc. Renewed process of modernisation and industrialisation Urjagram programme launched
1987	Establishment of IREDA	Indian Renewable Energy Development Agency (IREDA), set up by DNES, to operate a revolving

Year/Period	Department	Action
		fund for development, promotion and commercialisation of NRSE through provision of soft term financial assistance
8th five year plan		Shift of emphasis towards market orientation and commercialisation of technology in order to attract private investment
1992	DNES to MNES	DNES was given the permanent status and was converted into the Ministry of Non-conventional Energy Sources (MNES)

Till mid 1993, the MNES was organized broadly based on technology, individual technologies were promoted through design and development support, and through the establishment of large-scale demonstration programmes, e.g., the national programmes for biogas development, cookstoves dissemination, and wind energy. Through these programmes, a RET manufacturing base was created. The RET devices were procured by the government, either for demonstration projects (as for wind energy and for SPV community-lighting and power plant programmes), or for subsidized sales to consumers. A number of technology-support centres were created to promote technological up gradation by manufacturers, and to certify the quality of devices procured by the government. The devices and the subsidies were channeled to consumers through **SNA (State Nodal Agencies)** that were responsible for after-sales service and consumer support.

In order to give the required focus on commercialization, market orientation, and in order to have greater involvement of the private sector, the MNES was restructured in 1993 on the basis of end-use applications of technologies through horizontal integration of various technologies. The restructured MNES now has sectoral groups of:

1. Rural energy
2. Urban/industrial energy, and
3. Power generation.

Under the New Strategy and Action Plan of 1993, the following, two-pronged Action Plan was devised:

- High priority accorded to generation of grid quality power from wind energy, small hydropower, bio-energy and solar energy.

- Rural energisation programme is promoted through:

- electrification of villages through photovoltaic and biomass gasifier power systems
- supply of solar lanterns to unelectrified households
- use of solar water heating systems
- rural energy programmes viz National Project on Biogas Programme
- production of energy from agricultural waste, etc.

Currently, a three-fold strategy has been pursued by the government for promotion of RE sources through private sector involvement. These include:

- Providing budgetary resources by government for demonstration projects.

- Extending institutional finance from the *Indian Renewable Energy Development Agency (IREDA)* and other financial institutions for commercially viable projects, with private sector participation; and external assistance from international and bilateral agencies.

- Promoting private investment through fiscal incentives, tax holidays, depreciation allowance, facilities for wheeling and banking of power for the grid and the remunerative returns for the power provided to the grid.

The emphasis has shifted from direct financial incentives (e.g., capital subsidies) to indirect fiscal incentives (e.g. low interest loans, financing packages for consumers, reduced tariff and taxes, viable power-purchase prices, etc.). This has stimulated private-sector investment in wind and SPV power plants, as well as encouraged RET manufacturers and financing intermediaries to address the needs of consumers in their product design and system development. The current policy environment has been successful in creating one of the largest and most diverse renewable energy programs in the world, with a broad technological base and large human capacity.

IREDA (Indian Renewable Energy Development Agency Limited) was established in March 1987 as a public sector enterprise for the promotion, development, and financing of *new and renewable sources of energy* technologies. As on 31 December 1998, the cumulative sanctions by IREDA amounted to 23.79 billion rupees and the disbursements were 99.03 billion rupees. Concomitantly, this was accompanied by financial and technical assistance from the World Bank, the UNDP (United Nations Development Programme), the GEF (Global Environment Facility), and the Asian Development Bank.

Estimated potential of RETs

Table: Estimates of technical potential for renewable energy technologies

Source/Systems	Approximate potential
Biogas plants (nos.)	12 million
Improved cook stoves (nos.)	120 million
Biomass energy	17000 MW
Solar energy	20 MW/sq. km.
Wind energy	20000 MW
Small hydro power	10000 MW
Ocean energy	50000 MW

Wind energy

The wind power potential initially estimated at 20,000 MW has now been revised to 45,000 MW considering the technological advances and availability of modern equipment. The present installed capacity of wind represents a little over of 1% of the total installed power generating capacity in the country. More than 5 billion units of electricity has been generated and fed to the state grids from wind power plants.

Potential windy locations had been identified in the coastal region of southern Tamilnadu, Kerala, Gujarat, Lakshadeep, Andaman and Nicobar Islands, Orissa and Maharashtra. Some locations have also been identified in certain parts of Karnataka, Andhra Pradesh, Madhya Pradesh, Tamilnadu, West Bengal, Uttar Pradesh and Rajasthan.

Table: Wind monitoring stations with annual mean wind power density <150W/sq.m (as on June 1999)

S.No	State Sl.No.	Station	Latitude °N		Longituide °E		Annual mean wind speed (kmph)		Annual mean wind po density power (W/m^2	
							Measured at 20/25m	Extra polated at 30m	Measured at 20/25m	Extra polated 30m
	Tamil Nadu									
1	1	Achankuttam	08	57	77	28	18.60	20.00	270	335
2	2	Algiyapandiyapuram	08	56	77	39	20.90	22.30	301	371
3	3	Andhiyur	10	36	77	11	19.10	20.60	177	213
4	4	Andipatti	09	59	77	35	19.00	19.60	266	298
5	5	Arasampalayam	10	51	77	03	20.50	21.80	195	232
6	6	Ayikudy	09	00	77	21	21.40	23.50	305	390
7	7	Edayarpalayam	10	55	77	07	22.40	23.80	273	323
8	8	Ennore	13	16	80	19	19.30	20.80	139	177
9	9	Gangaikondan	08	51	77	35	18.40	19.00	246	267
10	10	Kannankulam	08	10	77	46	21.30	22.20	238	268
11	11	Kattadimalai	08	14	77	33	23.70	25.30	312	380
12	12	Kayattar I	08	58	77	44	20.30	21.50	294	342
13	13	Kayattar II	08	57	77	43	20.50	20.90	285	302
14	14	Kethanur	10	54	77	13	21.10	22.30	259	305
15	15	Kumarapuram	08	16	77	35	22.00	22.70	288	315
16	16	Mangalapuram	09	03	77	22	22.30	23.40	312	357
17	17	Meenakshipuram	09	52	77	18	16.40	17.50	224	267
18	18	Meetukadai	10	52	77	23	18.00	19.20	184	221
19	19	Muppandal	08	16	77	33	25.50	27.60	406	519
20	20	Myvadi	10	36	77	19	19.60	21.00	251	305
21	21	Naduvakkurichi	09	07	77	30	16.80	18.00	157	190
22	22	Nettur	08	54	77	33	19.90	20.20	338	358
23	23	Onamkulam	08	58	77	51	19.90	20.30	247	258

24	24	Ottapidaram	08	54	78	01	18.50	20.00	221	280
25	25	Ovan	08	18	77	53	18.20	19.20	160	184
26	26	Panakudi	08	19	77	33	22.90	23.90	366	408
27	27	Pongalur	10	58	77	21	19.10	20.40	213	251
28	28	Poolavadi	10	45	77	16	21.20	23.00	283	343
29	29	Poosanpattu	10	41	77	08	19.30	20.00	168	188
30	30	Puliyamkulam	08	19	77	44	18.90	20.80	188	245
31	31	Rameswaram	09	17	79	20	23.90	26.40	290	398
32	32	Sankanen	08	12	77	40	22.60	23.40	258	287
33	33	Sembagaramanpudur	08	16	77	31	21.70	23.00	300	367
34	34	Servallar Hills	08	42	77	21	17.80	18.90	207	247
35	35	Sultanpet	10	52	77	11	19.00	19.10	203	204
36	36	Talayathu	08	48	77	39	20.50	21.50	324	364
37	37	Thannirpandal	10	57	77	19	18.20	21.00	216	330
38	38	Tuticonn	08	50	78	08	17.60	19.00	148	185
39	39	Vakaikulam	08	45	78	00	16.60	17.90	167	201
		Gujarat								
40	1	Adesar	23	33	70	57	15.60	18.60	93	156
41	2	Amrapar (Gir)	21	10	70	26	19.67	21.29	147	186
42	2	Amrapar (Seth)	21	44	70	03	19.17	20.20	151	176
43	4	Bamanbore II	22	26	71	30	20.30	21.50	171	199
44	5	Bayath	22	56	69	11	17.65	20.06	118	180
45	6	Bhandanya	22	06	69	43	19.50	20.40	162	180
46	7	Dhank 1	21	48	70	08	24.40	25.50	312	353
47	8	Dhanik 2	21	48	70	08	25.10	25.50	327	344
48	9	Godladhar	22	03	71	20	19.45	22.50	144	216
49	10	Haripar	22	20	69	38	20.06	21.19	160	186
50	11	Harshad	21	50	69	22	20.00	21.40	164	193
51	12	Jafrabad	20	53	71	25	17.50	19.10	137	176
52	13	Jamanwada	23	35	68	36	18.60	20.70	149	202
53	14	Kalyanpur	22	03	69	24	22.10	23.70	208	253
54	15	Kera	23	04	69	36	19.42	20.41	135	156
55	16	Kukma	23	11	69	47	19.20	20.60	150	184
56	17	Lamba	21	54	69	19	20.00	21.10	164	191
57	18	Limbara	22	32	70	59	19.10	20.10	166	190
58	19	Mesaria	22	28	71	06	18.78	19.91	131	154
59	20	Moti Sindholi	23	11	68	43	17.50	20.40	118	180
60	21	Mundra	22	47	69	43	19.50	21.30	168	217
61	22	Nani Kundal	21	55	71	28	20.03	21.90	163	209
62	23	Navadra	21	57	69	16	20.80	22.40	183	226
63	24	Navi Bander	21	26	69	47	19.50	20.50	153	176

64	25	Okha	22	28	69	03	19.40	20.60	150	191
65	26	Okhamadhi	22	06	69	06	19.00	20.20	129	159
66	27	Sanodar	21	35	72	11	22.46	24.19	197	254
67	28	Sinai	23	03	70	04	20.78	21.84	183	207
68	29	Surajbari	23	14	70	39	19.50	22.00	184	268
		Orissa								
69	1	Chandipur	21	32	87	01	15.18	18.50	120	179
70	2	Chatrapur	19	18	84	58	14.40	16.50	106	158
71	3	Damanjodi	18	49	83	00	16.59	17.57	129	154
72	4	Gopalpur	19	16	84	54	16.20	18.10	124	173
73	5	Paradwip	20	23	86	41	18.20	20.10	153	201
74	6	Puri	19	48	85	49	17.50	18.80	137	166
		Maharashtra								
75	1	Alamprabhu Pathar	16	46	74	21	20.50	21.10	164	178
76	2	Chalkewadi	17	36	73	49	20.20	20.60	206	211
77	3	Dhalgaon	17	08	74	59	21.20	21.90	216	234
78	4	Dongerwadi	16	55	74	48	20.07	21.06	167	190
79	5	Gawalwadi +	20	06	73	43	18.00	19.06	127	164
80	6	Gude Panchagani	17	07	73	59	19.80	21.30	178	223
81	7	Kas @	17	44	73	49	19.05	20.02	173	189
82	8	Kavdya Donger +	19	01	74	32	22.03	22.08	209	222
83	9	Khandke	19	08	74	53	19.60	21.30	146	187
84	10	Kolgaon	18	50	74	43	20.50	21.00	177	190
85	11	Kotholi	16	58	73	58	17.80	18.10	164	171
86	12	Lonavla	18	46	73	23	15.50	17.70	122	176
87	13	Mandhardeo @	18	02	73	53	19.04	19.08	153	163
88	14	Matrewadi	17	12	73	56	20.80	21.10	211	218
89	15	Motha	21	24	77	22	18.70	19.10	146	154
90	16	Panchgani	17	55	73	48	18.40	19.70	133	160
91	17	Sautada`	18	48	75	20	21.20	21.90	167	182
92	18	Thoseghar	17	35	73	53	21.70	23.30	229	287
93	19	Vankusawade	17	28	73	50	21.20	21.70	231	247
94	20	Varekarwadi	17	13	73	59	21.04	21.50	257	264
95	21	Vijayadurg	16	30	73	20	19.60	20.60	207	225
		Andhra Pradesh								
96	1	Bdhrampalli Kottala	14	55	77	24	21.30	21.50	248	255
97	2	Bandarlapalli	15	01	78	04	20.79	21.60	240	265
98	3	Bhimunipatnam	17	54	83	27	19.10	20.10	195	229
99	4	Jamalamadugu 1	14	49	78	23	17.50	18.30	161	184
100	5	Jamalamadugu 2	14	46	78	22	18.60	19.40	165	183
101	6	Jangamguntla	15	39	79	08	16.03	16.60	149	164

102	7	Kadavakallu	14	48	77	56	22.10	22.30	303	308
103	8	Kakula Konda	13	43	79	21	23.10	25.00	332	404
104	9	Kondamithepalli	15	03	78	03	21.22	22.00	252	282
105	10	M P R Dam	14	54	77	25	19.90	20.70	228	245
106	11	Mustikovala	14	15	77	32	20.20	20.80	201	216
107	12	Nallakonda	14	07	77	34	22.80	23.10	276	288
108	13	Narasimha Konda	14	30	79	52	20.10	22.50	186	261
109	14	Nazreeabad	17	11	77	55	21.00	21.60	176	189
110	15	Pampanoor Thanda	14	38	77	24	19.60	20.10	182	194
111	16	Payalakuntla	14	53	79	02	20.10	20.40	230	241
112	17	Puttaparthy	14	09	77	48	17.70	18.00	149	156
113	18	Ramagiri I	14	17	77	31	19.50	20.90	205	246
114	19	Ramagiri III	14	22	77	32	19.40	20.20	190	213
115	20	Singanawala	14	46	77	44	23.80	24.20	366	377
116	21	Talaricheruvu	14	57	78	03	18.11	19.30	144	179
117	22	Tallimadugula	14	22	77	32	22.20	22.50	260	267
118	23	Tirumala	13	40	79	22	20.40	21.90	226	282
119	24	Tirumalayapalli	14	54	78	11	19.00	20.80	154	195
120	25	Vajrakarur	14	58	77	19	19.46	20.90	173	205
		Rajasthan								
121	1	Damotar	24	07	74	44	18.80	19.50	149	163
122	2	Devgarh	24	02	74	39	19.88	21.38	151	186
123	3	Harshnath	27	29	75	10	20.62	22.60	206	277
124	4	Jaisalmar	26	54	70	55	17.80	19.50	159	202
125	5	Jaswanthagad	24	47	73	28	18.90	19.40	142	152
126	6	Khodal	26	22	71	13	17.00	18.50	135	170
127	7	Mohangarh	27	17	71	13	15.50	17.50	117	161
128	8	Phalodi	27	07	72	20	17.40	19.20	142	185
	Lakshadweep									
129	1	Agathi	10	51	72	11	18.40	19.50	179	208
130	2	Kadmat	11	13	72	47	18.00	19.40	169	211
131	3	Kalpeni	10	05	73	39	16.20	18.90	125	182
132	4	Kavarathi	10	33	72	38	18.00	19.60	161	206
133	5	Minicoy	08	17	73	04	17.40	>17.40	162	>162
		Karnataka								
134	1	Arasinagundi	14	29	76	50	-	27.00	-	392
135	2	B B Hills	13	26	75	45	26.80	27.60	468	532
136	3	Bommanhalli	13	17	76	36	18.10	19.40	128	151
137	4	Bullenahalli 1	13	25	76	41	-	21.20	-	168
138	5	Bullenahalli 2	13	24	76	41	-	20.34	-	195
139	6	Chikodi	16	20	74	30	23.20	23.50	264	272

140	7	Godekere	13	20	76	40	19.80	19.90	155	157
141	9	Gokak	16	07	74	47	19.20	21.40	168	228
142	8	Gujanur	14	58	75	54	-	23.35	-	240
143	10	Hanamsagar	15	54	76	02	20.60	22.10	173	210
144	12	Hanumanhatil	15	55	74	43	20.30	22.10	165	213
145	11	Haradenahalli	12	51	76	13	18.50	19.70	127	151
146	13	Horti	17	05	75	40	19.80	20.10	173	180
147	14	Jogimatti	14	10	76	22	13.30	31.30	498	553
148	15	Jogimatti	14	11	76	25	-	31.03	-	582
149	16	Khamkarkatti	15	45	74	35	20.30	20.80	159	169
150	17	Khanderayanahalli	14	30	75	45	20.20	20.30	183	185
151	18	Madikaripura	14	13	76	27	-	27.13	-	365
152	19	Malgatti	15	52	75	55	19.60	121.90	156	219
153	20	Sangundi	16	15	75	44	18.70	20.40	153	193
154	21	Sogi A	14	55	75	59	-	26.56	-	415
155	22	Sogi B	14	54	75	59	-	24.48	-	271
Kerala										
156	1	Kanjicode	10	47	76	49	22.60	23.70	218	249
157	2	Kolahalamedu	09	40	76	56	16.90	17.80	146	174
158	3	Kotamala	10	40	76	36	19.20	20.50	154	187
159	4	Kottathara	11	07	76	39	19.70	20.70	207	243
160	5	Kulathummeddu	-		-		19.09	22.02	180	239
161	6	Kuttikanam	09	35	76	59	16.50	18.00	140	181
162	7	Panchalimedi	09	32	76	57	20.20	20.90	258	285
163	8	Parampukettimedu	09	54	77	13	26.05	28.05	450	528
164	9	Ponmudu	08	46	77	08	18.50	18.70	216	220
165	10	Pullikanam	09	44	76	52	18.20	18.50	178	187
166	11	Ramakalmedu	09	49	77	14	29.70	29.70	532	534
167	12	Senapathi	09	57	77	00	19.02	21.05	194	284
168	13	Tolanur	10	42	76	30	15.70	17.20	115	157
		Madhya Pradesh								
169	1	Jamgodrani	22	59	76	10	18.20	19.70	130	164
170	2	Kheda	22	36	75	38	18.50	19.70	126	152
171	3	Kukru	21	30	77	29	19.00	20.40	157	194
172	4	Mahuria	23	50	76	06	19.00	19.50	171	182
173	5	Sendhva	21	38	75	03	18.10	19.10	163	183
		West Bengal								
174	1	Fraserganj	21	34	88	15	17.70	18.25	147	158
175	2	Gangasagar	21	37	88	04	17.40	18.10	155	173
		Andaman & Nicobar								
176	1	Keating Point	09	15	92	46	16.06	19.10	114	175

		Uttar Pradesh								
177	1	Bachelikhal	30	04	78	37	18.06	20.01	144	181

Table: State-wise wind power installed capacity (as on 31.3.2000)

in MW

State	Demonstration projects	Commercial projects	Total capacity
Andhra Pradesh	3.050	84.990	88.040
Gujarat	17.345	149.565	166.910
Karnataka	2.575	31.650	34.225
Kerala	2.025	-	2.025
Madhya Pradesh	0.590	21.995	22.585
Maharashtra	6.440	72.840	79.280
Rajasthan	2.000	-	2.000
Tamil Nadu	19.355	751.380	770.735
Others	1.565	-	1.565
Total	**54.945**	**1112.420**	**1167.365**

Solar photovoltaic systems

Indian PV market can be divided as follows:

1. MNES supported subsidy market primarily for socially driven schemes
2. Commercial market for specialized applications such as in railways, telecommunications, and exports
3. Consumer oriented market primarily driven by availability of finance

The first segment of market consists of approximately 30% of the aggregate system installed capacity. Market share for commercial segment has been 46%, and remaining 24% is accommodated in the consumer oriented market.

In view of the current emphasis and commitment on deploying the PV technology through commercially sustainable routes, it is estimated that the market segment in the commercial and consumer segments will grow as fast as the growth projected in the government sector.

Of the several applications of PV, home systems for lighting with some additional power is emerging as the largest market. Market potential is unlimited in the above

segment as unelectrified as well as electrified but poorly serviced areas of rural and urban sectors represent this segment.

Table: Structure of Indian PV market

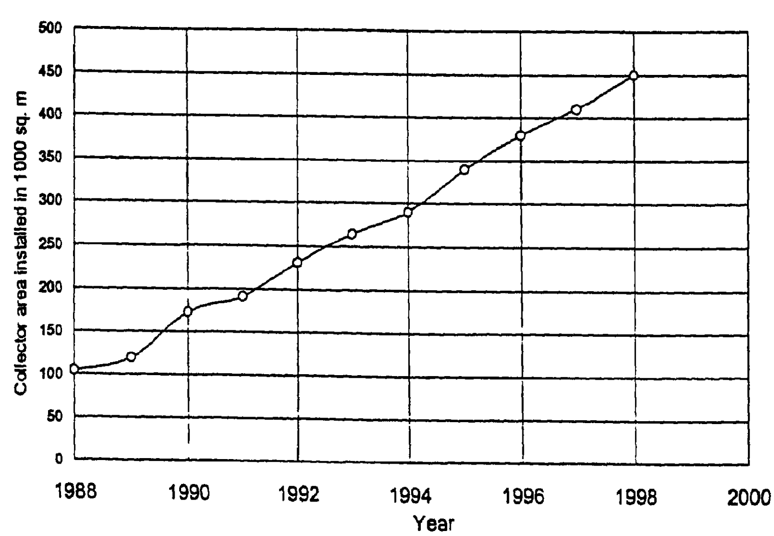
Market segment	System/product	Percentage share
Minimum rural energy needs	Lanterns Home lighting systems	5.16 7.92
Decentralized energy supply	Power plants for Rural electrification Water pumping Street lights	2 8 5.3
Grid connected power generation and supply	Centralized power plants Roof-top grid connected systems	2.1
Others and exports	Telecommunication equipment, Systems for railways, defense etc.	69

Total installed capacity: 58 mw (totaling 750,000 systems)

Solar water heating

A solar water heater serves the functions of collecting solar energy, utilizing this energy to heat water and storing hot water. The circulation of water in the system is possible due to the density difference or by utilizing a pump.

Figure: Cumulative growth in solar thermal systems (installed collector area)



In India, solar thermal systems are used for heating water for domestic and industrial purposes. In the industrial sector, these systems preheat boiler feed water and also supply direct process heat. The resultant savings are mainly in terms of boiler fuel. In the domestic sector, solar water heating systems primarily replace electric geysers. The small capacity systems (up to 2000 litre per day) work on natural circulation or thermosyphon principle. However, for larger capacity systems, pumps with necessary controls are required to circulate water and such systems are designated as 'forced flow' systems. The cumulative installed collector area in the country in 1998/99 was 450 000 m^2.

Biomass power

Biomass includes straw, stalks, stems and fines, agro-industrial processing residues such as shells, husks, deoiled cakes, forestry residues and biomass grown in specially dedicated energy plantation. Conversion technologies include combustion/inceneration, , gasification, pyrolysis etc.) using gas/steam turbine, dual fuel engine/gas engine, or combination thereof, either in power alone or in co-generation (of more than one energy forms - steam and power) mode.

Co-generation

Co-generation i.e. multiple and sequential use of a fuel for production of steam and power in a process industry, aims at surplus power generation in industries such as sugar mills, paper mills, rice mills, etc., where biomass resources are either generated or consumed in their main processing/production process.

Potential

19,500 MW

Table: Status of biomass power installations

Commissioned projects	222.0 MW	40 projects
Biomass power	39.0 MW	10 Projects
CO-generation	183.0 MW	30 Projects

Table: State-wise List of Commissioned Biomass Power Projects (in MW)

Sl. No	State	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	Total Capacity
1.	Andhra Pradesh	--	--	--	--	1.0	--	10.0	1.0	12.0
2.	Gujarat	--	--	--	--	--	--	0.5	--	0.5
3.	Haryana	4.0	--	--	--	--	--	--	--	4.0
4.	Karnataka	--	--	--	--	1.0	--	10.0	26.0	37.0
5.	Maharashtra	1.5	--	1.5	4.5	1.5	--	--	--	9.0
6.	Madhya Pradesh	--	--	--	--	--	--	5.0	--	5.0
7.	Punjab	--	10.0	--	--	--	--	--	--	10.0
8.	Tamil Nadu	3.0	3.0	4.0	19.0	25.5	33.5	10.0	--	98.0
9.	Uttar Pradesh	--	--	--	6.5	--	8.0	8.0	24.0	46.5
		8.5	13.0	5.5	30.0	29.0	41.5	43.5	51.0	222.0

Small hydel

Ministry of Non-conventional Energy Sources (MNES) has so far been responsible for small and mini hydro projects up to 3 MW station capacity. The subject of small hydro between 3-25 MW has recently been assigned to MNES.

India has 263 small hydropower projects up to 3 MW station capacity with an aggregate capacity of over 202 MW. These projects are spread throughout the country in hilly regions as well as on canal drops. Over 150 projects in this range with aggregate capacity of 145 MW are under construction.

The small hydropower projects are developed in the potential regions by the State Electricity Boards/ State Agencies responsible for SHP development. Most of the SHP projects are grid connected. However, there are some projects, which are decentralized and are managed by local community/ NGOs.

Table: Identified small hydro potential sites in india (Up to 3 mw capacity)

Sl.No.	Name of State	Identified Sites	Project capacity
1	Haryana	21	24.05
2	Himachal Pradesh	166	216.03
3	Jammu & Kashmir	106	145.52
4	Punjab	78	65.26
5	Rajasthan	49	27.26
6	Uttar Pradesh	310	326.63
7	Gujarat	283	113.33
8	Madhya Pradesh	99	74.63
9	Maharashtra	183	123.57
10	Andhra Pradesh	271	114.88
11	Karnataka	181	166.11
12	Kerala	167	199.10
13	Tamilnadu	131	141.92
14	Bihar	158	199.37
15	Orissa	152	88.76
16	Sikkim	52	56.25
17	West Bengal	141	153.87
18	Arunachal Pradesh	433	382.31
19	Assam	38	50.00
20	Manipur	91	59.75
21	Meghalaya	83	41.00
22	Mizoram	73	42.32
23	Nagaland	67	26.89
24	Tripura	8	9.85
25	A&N Island	5	1.15
26	Goa	3	2.60
	Total	**3349**	**2852.41**

Rural energy

National Project on Biogas Development (NPBD), which caters to family type biogas plants. It was started in 1981-82 with the following objectives:

- To provide fuel for cooking purposes and organic manure to rural households through biogas plants.
- To mitigate drudgery of rural women, reduce pressure on forest and accentuate social benefits
- To improve sanitation in villages by linking toilets with biogas plants.

Table: Cumulative achievement under NPBD, against estimated potential of biogas plants (up to 31st March 2000)

State/UTs	Number of Biogas plants		
	Estimated potential	Installed during 1981-82 to 1999-2000	Coverage of estimated potential in %age
Andhra Pradesh	10,65,600	2,82,557	27
Arunachal Pradesh	7,500	742	10
Assam	3,07,700	41,896	14
Bihar	9,39,900	1,16,621	12
Goa	8,000	3,188	40
Gujarat	5,54,000	3,35,315	61
Haryana	3,00,000	39,865	13
Himachal Pradesh	1,25,600	42,547	34
Jammu & Kashmir	1,28,500	1,862	1
Karnataka	6,80,000	2,77,561	41
Kerala	1,50,500	64,816	43
Madhya Pradesh	14,91,200	1,78,304	12
Maharashtra	8,97,000	6,47,443	72
Manipur	38,700	1,793	5
Meghalaya	24,000	1,279	5
Mizoram	2,200	1,976	90
Nagaland	6,700	1,097	16
Orissa	6,05,500	1,60,010	26
Punjab	4,11,600	56,348	14
Rajasthan	9,15,300	65,185	7
Sikkim	7,300	2,494	34
Tamilnadu	6,15,800	1,96,545	32
Tripura	28,500	1,164	4
Uttar Pradesh	20,21,000	3,40,312	17
West Bengal	6,95,000	1,68,297	24
A & N Islands	2,200	137	6
Chandigarh	1,400	97	7
Dadra & Nagar Haveli	2,000	169	8
Delhi	12,900	673	5
Pondicherry	4,300	539	13
Total	**1,20,49,900**	**30,30,832**	**25.15**

Table: Cumulative achievement up to 31st March 2000 under Community, Institutional & Night Soil based Biogas Plants Programme

State/U.T.	Number of CBP/IBP/NBP Installed
Andhra Pradesh	105
Assam	2
Bihar	37
Goa	20
Gujarat	147
Haryana	41
Himachal Pradesh	7
J&K	4
Karnataka	48
Kerala	45
Madhya Pradesh	116
Maharashtra	413
Manipur	4
Meghalaya	2
Nagaland	7
Orissa	33
Punjab	558
Rajasthan	55
Tamil Nadu	201
Uttar Pradesh	1146
West Bengal	51
Delhi	32
Pondicherry	1
Total	**3,075**

Municipal and solid wastes

Under *National Programme on Energy Recovery from Urban, Municipal and Industrial Wastes* 4 nos. of power generation plants of aggregate capacity 8.45 MW have already been completed and 9 waste-to-energy project proposals are under development.

Potential

A potential for generating about 1000 MW of power from urban and municipal wastes and about 700 MW from industrial wastes is estimated for the country. This potential is likely to increase further with economic development.

Environment

'able 1 Air quality guidelines for "classical pollutants" set by World Health Organisation (WHO)

Pollutant	Time-weighted average	Averaging time
Sulphur dioxide	500	10 minutes
	50	1 year
	125	24 hours
Carbon monoxide	60000	30 minutes
	30000	1 hour
	10000	8 hours
Nitrogen dioxide	200	1 hour
	40	1 year
Ozone	120	8 hours
Lead	0.5	1 year

Source

WHO 1999. Guidelines for air quality, WHO, Geneva

Table 2 Ambient air quality standards in India

Pollutant and time-weighted average	Concentration in ambient air (µg/m³) Industrial area	Residential, rural, and other areas	Sensitive area	Methods of measurement
Sulphur dioxide				
Annual average	80	60	15	Improved West and Gaeke method
24 hours	120	80	30	Ultraviolet fluorescence
Oxides of nitrogen				
Annual average	80	60	15	Jacob and Hochheiser modified (Na-Arsenite) method
24 hours	120	80	30	Gas-phase chemiluminescence
Suspended particulate matter				
Annual average	360	140	70	High-volume sampling (average flow rate not less than 1.1 m³ per minute)
24 hours	500	200	100	
than 10 µm)				
Annual average	120	60	50	Respirable particulate matter sampler
24 hours	150	100	75	
Lead				
Annual average	1	0.75	0.5	Atomic absorption spectrometry after sampling using EPM 2000 or an
24 hours	1.5	1	0.75	
Carbon monoxide[a]				
8 hours	5 [a]	2 [a]	1 [a]	Non-dispersive infrared spectroscopy
1 hour	10 [a]	4 [a]	2 [a]	
Ammonia				
Annual average	–	400 [a]	–	–
24 hours	–	100 [a]	–	–

[a] mg/m³

Notes

1 Annual average is annual arithmetic mean of minimum 104 measurements in a year taken twice a week at 24-hourly intervals.

2 24-hourly and 8-hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

3 NAAQS, the levels of air quality necessary with an adequate margin of safety to protect public health, vegetation, and property.

4 Whenever and wherever two consecutive values exceed the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.

5 The state government / state board shall notify the sensitive and other areas in the respective states within a period of six months from the date of notification of NAAQS.

6 Standard for ammonia specified vide notification dated 14 October 1998. It does not mention about the type of areas for its applicability nor the method of measurement is being specified.

Table 3 Noise standards

Area code	Category of area	Limits in dB(A)	
		Day-time (6 a.m. to 9 p.m.)	Night-time (9 p.m. to 6 a.m.)
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D[a]	Silence zone	50	40

[a] area up to 100 m around premises such as hospitals, educational institutions, and courts

Note

The silence zones are to be declared by the competent authority Use of vehicular horns, loudspeakers, and bursting of crackers are banned in these zones.

Source

CPCB. 1998 Pollution Control Acts, Rules, and Notifications issued thereunder. Volume I. p. 313. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

For more details, please see TEDDY ONLINE+ [Section: Environment (noise)]

Sources
1 CPCB 1994 Central Pollution Control Board Notification. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests.
2 CII 1999 Environmental legislation in India. A Guide for Industry and Business. New Delhi: Environment Management Division, Confederation of Indian Industry.

Table 4 Criteria for classification of inland surface water

Parameter	Maximum/minimum	Drinking water without conventional treatment but after disinfection	Outdoor bathing, organized	Drinking water with conventional treatment followed by disinfection	Propagation of wildlife and fisheries	Irrigation, industrial cooling, etc.
Dissolved oxygen (mg/litre)	Minimum	6	5	4	4	–
Biological oxygen demand (mg/litre)	Minimum	2	3	3	–	–
Total coliform bacteria (most probable number per 100 millilitres)	Maximum	50	500	5000	–	–
Total dissolved solids (mg/litre)	Maximum	500	–	1500	–	2100
Chloride as chlorine (mg/litre)	Maximum	250	–	600	–	500
Colour (hazen)	Maximum	10	300	300	–	–
Sodium absorption ratio	Maximum	–	–	–	–	26
Boron (mg/litre)	Maximum	–	–	–	–	2
Sulphates (mg/litre)	Maximum	400	–	400	–	1000
Nitrates (mg/litre)	Maximum	20	–	50	–	–
Free ammonia as nitrogen (mg/litre)	Maximum	–	–	–	12	–
Conductivity at 25 °C (µs/cm)	Maximum	–	–	–	1	2.25
pH		6.5-8 5	6.5–8.5	6.5–8.5	6.5–8.5	6.0–8.0
Arsenic (mg/litre)	Maximum	0.05	0.2	0.2	–	–
Iron (mg/litre)	Maximum	0 3	–	50	–	–
Fluorides (mg/litre)	Maximum	1 5	1.5	1	–	–
Lead (mg/litre)	Maximum	0 1	–	0.1	–	–
Copper (mg/litre)	Maximum	1 5	–	1.5	–	–
Zinc (mg/litre)	Maximum	15	–	15	–	–

Source

ISI. 1982 Indian Standards (IS· 2291) New Delhi: Indian Standards Institute

Table 5. Maximum permissible limits (mg/litre) for industrial effluent discharges

Parameter	*Into inland surface waters Indian Standards: 2490 (1974)*	*Into public sewers Indian Standards: 3306 (1974)*	*On land for irrigation Indian Standards: 3307 (1974)*
pH	5.5-9.0	5.5-9.0	5.5-9.0
Biological oxygen demand (for 5 days at 20 °C)	30	350	100
Chemical oxygen demand	250		
Suspended solids	100	600	200
Total dissolved solids (inorganic)	2100	2100	2100
Temperature (°C)	40	45	-
Oil and grease	10	20	10
Phenolic compounds	1	5	-
Cyanides	0.2	2	0.2
Sulphides	2	-	-
Fluorides	2	15	-
Total residual chlorine	1	-	-
Pesticides	-	-	-
Arsenic	0.2	0.2	0.2
Cadmium	2	1	-
Chromium (hexavalent)	0.1	2	-
Copper	3	3	-
Lead	0.1	1	-
Mercury	0.01	0.01	-
Nickel	3	3	-
Selenium	0.05	0.05	-
Zinc	5	15	-
Chlorides	1000	1000	600
Boron	2	2	2
Sulphates	1000	1000	1000
Sodium (%)	-	60	60
Ammoniacal nitrogen	50	50	-
Radioactive materials			
Alpha emitters (milli curie/millilitre)	10^{-7}	10^{-7}	10^{-8}
Beta emitters (μ curie/millilitre)	10^{-6}	10^{-6}	10^{-7}

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder.** Volume I. pp. 311-312. New Delhi: Central Pollution Control Board. Ministry of Environment and Forests. 501 pp.

Table 6 Maximum permissible limits (mg/m^3) for emissions of particulate matter from thermal power stations

Boiler size (MW)	*Protected areas*	*Other areas*
Less than 210	150	350
210 or more	150	150

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder.** Volume I. p. 280. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests 501 pp.

Table 7 Maximum permissible limits (mg/m^3) for emissions from integrated iron and steel plants

Pollutant and sources	*Emission limit*
Particulate matter	
Sintering plant	150
Coke oven	50
Steel making	–
During normal operation	150
During oxygen lancing	400
Carbon monoxide	
Coke oven (kilogram per tonne of coke produced)	3

Source

CPCB. 1998 **Pollution Control Acts, Rules, and Notifications issued thereunder** Volume I, p. 279 New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

For more details, please see TEDDY ONLINE+ [Section: Environment (air: industry)]

Table 8 Maximum permissible limits (mg/m³) for emissions of particulate matter from cement plants

Capacity (tonnes per day)	*Protected areas*	*Other areas*
200	250	400
Greater than 200	150	250

Source

CPCB 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder** Volume I. p. 270.
New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 9 Effluent standards for Al (aluminium) industry

Plant	Parameter	Permissible limit
Alumina plant		
Raw material handling	Primary and secondary crusher particulate matter	150 mg/m³
Precipitation area: calcination	Particulate matter	250 mg/m³
	Carbon monoxide	1% maximum
	Stack height[a]	
Smelter plant		
Green anode shop	Particulate matter	150 mg/m³
Anode bake oven	Particulate matter	150 mg/m³
	Total fluoride	0.3 kg/tonne of Al
Potroom	Particulate matter	150 mg/m³
	Total fluoride	
	Vertical stud soderberg	4.7 kg/tonne of Al produced
	Horizontal stud soderberg	6.0 kg/tonne of Al produced
	Prebacked side worked	2.5 kg/tonne of Al produced
	Prebacked centre worked	1.0 kg/tonne of Al produced
	Stack height[a]	

[a] $H = 14\,Q^{0.3}$, where Q is the emission rate of sulphur dioxide in kg/h and H is the stack height in metres.

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder. Volume I. pp. 284-285.**
New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 10 Maximum permissible limits for (kilogram per tonne of feed*) emissions of sulphur dioxide from oil refineries

Process	*Emission limit*
Atmospheric and vacuum distillation	0.25
Catalytic cracker	2.50
Sulphur recovery unit	120.00

* indicates the feed for the specific part of the process under consideration.

Source

CPCB. 1998. Pollution Control Acts, Rules, and Notifications issued thereunder Volume I. p. 284. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 11 Maximum permissible limits (mg/m^3) for emissions of particulate matter from calcium carbide plants

Source	*Emission limit*
Kiln	250
Arc furnace	150

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder.** Volume I p. 278. New Delhi Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 12 Maximum permissible limits for emissions from copper, lead, and zinc smelting units

Pollutant	*Source*	*Emission limit*
Particulate matter	Concentrator	150 F3mg/m^3
Oxides of sulphur[a]	Smelter and convertor	4 kg per tonne of concentrated

[a] off-gases must be utilized for sulphunc acid manufactunng

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder.** Volume I. p. 279. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 13 Maximum permissible limits (mg/m^3) for emissions of particulates from carbon black industry

Pollutant	*Emission limit*
Particulate matter	150

Source

CPCB. 1998. Pollution Control Acts, Rules, and Notifications issued thereunder. Volume I, p. 279. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 14 Maximum permissible limits (mg/m^3) for emissions of particulate matter from aluminium industry

Process	*Emission limit*
Calcination	250
Smelting	150

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder.** Volume I. p. 278. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests 501 pp.

Table 15 Effluent standards for sugar industry

Parameter	Permissible limit (mg/litre)	
	Disposal on land	Disposal in surface water
Biological oxygen demand (5 days at 20 °C)	100	30
Suspended solids	100	30

Source

CPCB. 1998. Pollution Control Acts, Rules, and Notifications issued thereunder. Volume I. p. 267. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 16 Effluent standards for large pulp and paper industries

Capacity (tonnes a year)	Parameter	Permissible limit
Above 24,000	pH	7.0-8.5
	Biological oxygen demand at 20°C	30 mg/litre
	Chemical oxygen demand	350 mg/litre
	Suspended solids	50 mg/litre
	Total organic chloride	2.0 kg/tonne of paper produced
	Flow (total waste water discharge)	
	Large pulp and paper[a]	200 m^3/tonne of paper produced
	Large rayon grade newsprint	150 m^3/tonne of paper produced

[a] the standards with respect to total waste water discharge for large pulp and paper mills established from 1992 will meet the standards of 100 m^3/tonne of paper produced

Source

CPCB. 1998. Pollution Control Acts, Rules, and Notifications issued thereunder. Volume I. p. 296. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 17 Effluent standards (mg/litre, except for pH) for oil refinery industry

Parameter	Permissible limit	Quantum (kg/thousand tonnes of crude processed)
Oil and grease	10.0	7.00
Phenol	1.0	0.70
Sulphide	0.5	0.35
Biological oxygen demand (5 days at 20 °C)	15.0	10.50
Suspended solids	20.0	14.00
pH	–	6.00–8.50

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder**. Volume I p. 266.
New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 18 Effluent standards (mg/litre, except for pH) for petrochemical (basic and intermediates) industry

Parameter	*Permissible limit*
pH	6.5-8.5
Biological oxygen demand (5 days at 20 °C)[a]	50.0
Phenol [b]	5.0
Sulphide (as S)	2.0
Chemical oxygen demand	250.0
Cyanide (as CN)	0.2
Fluoride (as F)[c]	15.0
Total suspended solids	1000.0
Hexavalent chromium	0.1
Total chromium (as Cr)[d]	2.0

[a] the state board may prescribe the BOD (biological oxygen demand) value of 30 mg/litre if the recipient system so demands

[b] the limit for phenol shall be confirmed at the outlet of effluent treatment of phenol plant. However, at the final disposal point, the limit shall be less than 1 mg/litre.

[c] the limit for fluoride shall be confirmed at the outlet of the chrome removal unit. However, at the disposal point, fluoride concentration shall be lower than 5 mg/litre.

[d] the limits for total and hexavalent chromium shall be confirmed at the outlet of the chromate removal. This implies that in the final treated effluent total, and hexavalent chromium shall be lower than prescribed herein.

Source

CPCB. 1998. Pollution Control Acts, Rules, and Notifications issued thereunder Volume I. p. 286. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

ble 19 **Effluent standards for thermal power plants**

charges from	*Parameter*	*Maximum limiting concentration (mg/litre) (except for pH and temperature)*
ndenser cooling waters	pH	6 5-8 5
ıce through the cooling system)	Temperature	Not more than 5 °C than the ıntake water temperature
	Free available chlorine	0.5
iler blow-downs	Suspended solids	100
	Oil and grease	20
	Copper (total)	1
	Iron (total)	1
›oling tower blow-downs	Free available chlorine	0 5
	Zinc	1.0
	Chromium (total)	0.2
	Phosphate	5.0
	matenal	Central Board in case of union temtories and state board in
sh pond effluent	pH	6.5-8.5
	Suspended solids	100
	Oil and grease	20

ource
:PCB. 1998. ***Pollution Control Acts, Rules, and Notifications issued thereunder***. Volume I. p. 267.
lew Delhi: Central Pollution Control Board, Ministry of Environment and Forests 501 pp.

or more details, please see TEDDY ONLINE+ [Section: Environment (air: power)]

Table 20 Emission factors (g/km) for different vehicles

Vehicle	*Carbon monoxide*	*Hydro carbons*	*Oxides of nitrogen*	*Sulphur dioxide*	*Lead*	*Total suspended particulate matter*
Two-wheeler	8.3	5.18	0.10	0.05	0.05	0.05
Cars (petrol)	(28.90[b])2.60[a]	6.2-0.30	2.70-0.60	0.22-0.14	0.01	0.33-0.08
Three-wheeler	12.25	7.65	0.10	0.10	0.01	0.50
Cars (diesel)	1.10	0.28	1.40	0.93	–	0.60
Bus	12.70	2.10	21.00	2.50	–	2.00
Truck	12.70	2.10	21.00	2.50	–	2.00
Light commercial vehicle	5.39	0.66	9.34	0.90	–	0.83

[a] new cars with catalytic convertors
[b] pre-1984 model cars

Source

IIP.1985. **State of Art Report on Vehicle Emissions.** Dehra Dun: Indian Institute of Petroleum.

Table 21 Emission limits (%) for petrol-driven vehicles (idling condition)

Parameter	*Type of vehicle*	*Limit (% by volume)*
Carbon monoxide	Four-wheelers	3.0
	Two- and three-wheelers	4.5

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder.** Volume I, p. 314. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

Table 22 Emission limits for diesel vehicles

Method of test	Light absorption coefficient (milli litre)	Maximum smoke density: Bosch units	Maximum smoke density: Hartridge units
Full load at a speed of 60%–70% of maximum engine-rated speed specified by the manufacturer	3.1	5.2	75
Free acceleration	2.3	–	65

Source

CPCB. 1998. **Pollution Control Acts, Rules, and Notifications issued thereunder** Volume I. p. 314. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests. 501 pp.

e23 **Mass emission standards (g/km) for petrol-driven vehicles**

		1 April 1996		1 April 2000	1 April 2005
	1 April 1991	*without catalytic converter*	*with catalytic converter*	Euro I Norm	Euro I Norm
·wheeled passenger :le					
ırbon monoxide	14.3–27.1	8.68–12.40	4.34–6.20	2.72	2.2
ydrocarbon	2.0–2.9	–	–	–	–
ydrocarbon and oxides of nitrogen	–	3 00–4.36	1.50–2.18	0.97	0.5

	1 April 1991	1 April 1996 Indian driving cycle	1 April 1998 Indian driving cycle	1 April 2000 with cold start
·-wheelers				
:arbon monoxide	12–30	4.5	4.5	2
·lydrocarbon	8–12	–	–	–
·lydrocarbon and oxides of nitrogen	–	3.6	3.6	2

	1 April 1991	1 April 1996 Indian driving cycle	1 April 1998 Indian driving cycle	1 April 2000 with cold start
:ee-wheelers				
Carbon monoxide	12–30	6.75	6.75	4
Hydrocarbon	8–12	–	–	–
Hydrocarbon and oxides of nitrogen	–	5.4	5.4	2

ıurce

ımpiled by TERI from Fuel and Vehicular Technology, Association of Indian Automobile Manufacturers, New Delhi. 1999.

Table 24

Mass emission standards (g/kWh) for diesel-driven vehicles

	1 April 1992	*1 April 1996*	*1 April 2000*	*Euro II*	*Euro III*
Gross vehicle weight					
>3.5 tonnes					
Carbon monoxide	14.0	11.2	4.50	4.00	2.0
Hydrocarbon	3.5	2.4	1.10	1.10	0.6
Oxides of nitrogen	18.0	14.4	8.00	7.00	5.0
Particulate matter for >85 kW	0	0	0.36	0.15	0.1
Particulate matter for <85 kW	0	0	0.61	0.15	0.1

	(g/kWh)	*(g/km)*	*(g/km)*
Gross vehicle weight			
< 3.5 tonnes			
Carbon monoxide	14.0	5.0-9.0	2.72-6.90
Hydrocarbon	3.5	–	–
Oxides of nitrogen	18.0	2.0-4.0	0.97-1.70
Particulate matter	0.0	–	0.14-0.25

Source

Compiled by TERI from Fuel and Vehicular Technology,
Association of Indian Automobile Manufacturers, New Delhi. 1999.

Table 2.1 Air quality data for different cities/ towns (1997)

State / Union Territory	Sulphur dioxide		Oxides of nitrogen		Suspended particulate matter	
	Industrial	Residential	Industrial	Residential	Industrial	Residential
Andhra Pradesh						
Hyderabad	53.8	44.8	97.7	86.5	459	405
Vishakhapatnam	26.4	67.3	40.3	136.3	159	592
Bihar						
Dhanbad	–	37.3	–	47.5	–	181
Jhana	45.0	–	57.0	–	408	–
Patna	–	41.9	–	49.3	–	832
Sindri	41.0	–	54.4	–	212	–
Delhi	90.8	56.3	172.4	134.0	1,689	1,399
Gujarat						
Ahmedabad	7.6	52.9	13.3	66.5	219	722
Ankleshwar	27.2	35.7	17.9	27.9	169	976
Surat	–	54.9	–	17.5	–	412
Vadodara	36.3	80.3	9.0	26.5	285	595
Vapi	–	32.4	–	40.0	–	321
Goa						
Ponda	–	11.2	–	20.5	–	123
Vasco	9.7	–	18.1	–	94	–
Himachal Pradesh						
Damtal	–	6.3	–	10.4	–	100
Parwanoo	6.1	6.8	13.8	14.2	132	118
Shimla	–	6.4	–	17.9	–	97
Haryana						
Faridabad	37.8	–	14.6	–	405	–
Yamuna Nagar	27.8	–	17.9	–	143	–
Karnataka						
Bangalore	53.4	30.3	37.3	22.1	304	222
Mysore	64.7	–	59.7	–	212	–
Kerala						
Kochi	31.5	14.6	41.4	35.6	340	225
Thiruvananthapuram	25.5	24.8	23.1	45.1	180	269
Kottayam	6.2	6.1	28.8	19.1	95	44
Kozhikode	–	12.6	–	17.1	–	152
Maharashtra						
Mumbai	36.0	39.2	35.9	67.1	240	653
Nagpur	20.7	30.9	38.5	71.3	254	611
Pune	111.8	50.3	126.1	60.4	698	204
Madhya Pradesh						
Bhilai	33.1	31.1	37.4	68.4	223	276
Bhopal	17.3	31.7	28.9	49.7	300	467
Indore	7.3	14.4	10.2	19.9	232	408
Jabalpur	–	6.0	–	11.9	–	77
Korba	–	30.2	–	40.8	–	279
Nagda	81.8	116.3	26.4	86.8	109	285
Raipur	9.1	8.4	27.4	24.4	183	156
Satna	14.6	11.9	16.5	13.3	205	146
Orissa						
Angul	12.7	20.9	9.8	21.4	97	106
Rourkela	54.0	–	45.3	–	314	–
Punjab						
Jalandhar	–	46.0	–	77.4	–	399
Ludhiana	40.5	18.4	92.6	42.8	651	245
Rajasthan						
Alwar	13.6	26.8	78.7	155.7	418	595

Table 2.2 Ambient Air Quality Status of various Cities/Towns during 1997

Pollution Level	Annual Mean Concentration Range (µg/m3)			
	Industrial (I)		Residential(R)	
	SO2 & NO2	SPM	SO2 & NO2	SPM
Low (L)	0-40	0-180	0-30	0-70
Moderate (M)	40-80	180-360	30-60	70-140
High (H)	80-120	360-540	60-90	140-210
Critical (C)	>120	>540	>90	>210

State / City	Sulphur dioxide		Nitrogen dioxide		SPM	
Area class	I	R	I	R	I	R
Andhra Pradesh						
Hyderabad	L	L	M	L	M	H
Vishakhapatnam	L	M	M	C	L	C
Assam						
Bihar						
Jharia	M	-	M	-	H	-
Dhanbad	-	M	-	M	-	H
Jamshedpur	M	M	M	M	L	M
Patna	-	L	-	M	-	C
Sindri	M	-	M	-	M	-
Delhi						
Delhi	L	L	M	M	H	C
Gujarat						
Ahmedabad	L	L	L	M	-	-
Goa						
Vasco	L	-	L	-	L	-
Ponda	-	L	-	L	-	M
Himachal Pradesh						
Shimla	-	L	-	L	-	M
Damtal	-	-	-	L	-	H
Parwanoo	-	-	-	L	-	M
Paonta Sahib	-	-	L	-	M	-
Haryana						
Yamuna Nagar	L	-	L	-	L	-
Karnataka						
Bangalore	L	M	L	L	M	C
Mysore	L	-	L	-	L	-
Kerala						
Cochin	L	L	L	L	L	-
Chingavanam	L	-	L	-	L	-
Kottayam	L	-	L	-	L	-
Kozhikode	L	L	L	L	L	M
Trivandrum	L	L	L	L	M	M
Maharashtra						
Bombay	L	L	L	M	-	-
Chanderpur	L	M	M	M	L	M
Dombivali	L	L	L	L	L	M
Nagpur	L	L	L	L	L	H
Nasik	L	M	L	M	L	C
Solapur	L	L	M	M	M	C
Meghalaya						
Shillong	-	L	-	L	-	L
Madhya Pradesh						
Bhilai	L	M	L	M	M	H
Bhopal	L	L	L	M	M	C
Indore	L	L	L	L	M	C
Jabalpur	-	-	-	L	-	M

Table 2.3 Number of stations violating annual and 24 hourly standards

Area Class	SO2		NO2		SPM	
	24-hourly	Annual	24-hourly	Annual	24-hourly	Annual
Residential	3	1	12	2	60	44
Industrial	4	2	5	1	14	6
Sensitive	1	1	1	1	3	2
Total	8	4	18	4	77	52

Source. CPCB 1999a

Table 2.4 Avearge noise levels (dB [A]) in various metropolitan cities

Metropolitan cities	*Industrial area*	*Commercial area*	*Residential area*	*Silence area*
Calcutta				
Day	78	82	79	79
Night	67	75	65	65
Mumbai				
Day	76	75	70	66
Night	65	66	62	52
Chennai				
Day	71	78	66	63
Night	66	71	48	49
Bangalore				
Day	78	76	67	67
Night	53	57	50	–

Source

MoEF. 1995. ***State of the Environment***. New Delhi: Ministry of Environment and Forests.

Table 2.5 GPIs (Grossly polluting industries) discharging into water course in states and union territories

State / Union Territory	Number of GPIs
State	
Andhra Pradesh	64
Assam	12
Bihar	68
Goa	1
Gujarat	19
Haryana	128
Himachal Pradesh	51
Jammu and Kashmir	–
Karnataka	5
Kerala	12
Madhya Pradesh	16
Maharashtra	–
Nagaland	–
Orissa	25
Punjab	20
Rajasthan	14
Tamil Nadu	714
Delhi	7
Uttar Pradesh	372
West Bengal	–
Union Territory	
Andaman and Nicobar Islands	–
Daman and Diu, Dadra and Nagar Haveli	–
Lakshadweep	–
Pondicherry	4
Total	1532

Note

There are no GPIs discharging into water course in Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim, Tripura, and Chandigarh.

Source

CPCB. 1997. ***Annual Report 1996/97***. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests.

Table 2.6 List of polluted river stretches in India

River	Polluted stretch	d	Existing class	Critical parameters	Possible sources of pollution
Sabarmati	Immediate upstream of Ahmedabad	B	E	Dissolved oxygen, BOD, coliforms	Domestic and industrial waste from Ahmedabad
	Sabarmati Ashram to Vautha	D	E	Dissolved oxygen, BOD, coliforms	Domestic and industrial waste from Ahmedabad
Subernarekha	Hatia Dam to Baharagora	C	Partly D and partly E	Dissolved oxygen, BOD, coliforms	Domestic and industrial waste from Ranchi and Jamshedpur
Godavari	Downstream of Nasik to Nanded	C	Partly D and partly E	BOD	Waste from sugar, distillery, and food-processing industries
	City limit to Nasik and Nanded	B	Partly D and partly E	BOD	Waste from sugar, distillery, and food-processing industries
Krishna	Karad to Sangli	C	Partly D and partly E	BOD	Waste from sugar and distillery industries
Indus (tributaries, Sutlej)	Downstream of Ludhiana to Harike	C	Partly D and partly E	Dissolved oxygen, BOD	Industrial waste from hosieries, tanneries, electroplating, and engineering
	Downstream of Nangal to Anandpur	C	E	Ammonia	Wastes of fertilizer, chlor alkali, and paper mills from Nangal
Ganga (tributaries)					
Yamuna	Delhi to confluence with Chambal	C	Partly D and partly E	Dissolved oxygen, BOD, coliforms	Domestic and industrial waste from Delhi, Mathura, and Agra
	In the city limits of Delhi, Mathura	B	Partly D and partly E	Dissolved oxygen, BOD, coliforms	Domestic and industrial waste from Delhi, Mathura, and Agra
Hindon	Saharanpur to confluence with Yamuna	D	E	Dissolved oxygen, BOD, coliforms	Industrial and domestic waste from Saharanpur and Ghaziabad
Chambal	Downstream of Nagda and downstream of Kota	C	Partly D and partly E	BOD, dissolved oxygen	Domestic and industrial waste from Nagda and Kota
Damodar	Downstream of Dhanbad to Haldia	C	Partly D and partly E	BOD, toxic	Industrial waste from Dhanbad, Durgapur, Asansol, Haldia, and Bumpur
Gomti	Lucknow to confluence with Ganga	C	Partly D and partly E	Dissolved oxygen, BOD, coliforms	Industrial waste from distilleries and domestic waste from Lucknow
Kali	Downstream of Modinagar to confluence with Ganga	C	Partly D and partly E	BOD, coliforms	Industrial and domestic waste from Modinagar

B: outdoor bathing, organized
C: drinking water source with conventional treatment followed by disinfection
D: propagation of wildlife and fisheries
E: irrigation, industrial cooling, etc.
BOD: biological oxygen demand

Source
MoEF. 1993. *National Environment Programme*. p.167. New Delhi: Ministry of Environment and Forests. 220 pp.

Table2.7. State wise distribution of Industries

S.No.	STATE/UT	Total No. of Units
1	Andhra Pradesh	173
2	Arunachal Pradesh	0
3	Assam	15
4	Bihar	62
5	Goa	6
6	Gujarat	177
7	Haryana	43
8	Himachal Pradesh	9
9	Jammu & Kashmir	8
10	Karnataka	85
11	Kerala	28
12	Madhya Pradesh	78
13	Maharashtra	335
14	Manipur	0
15	Meghalaya	1
16	Mizoram	0
17	Nagaland	0
18	Orissa	23
19	Punjab	45
20	Rajasthan	49
21	Sikkim	1
22	Tamil Nadu	119
23	Tripura	0
24	UT-Andman & Nicobar	0
25	UT- Chandigarh	1
26	UT- Daman & Diu, Dadra & Naga	0
27	UT-Delhi	5
28	UT- Lakshadweep	0
29	UT- Pondichery	6
30	Uttar Pradesh	224
31	West Bengal	58
	TOTAL	1551

Table 2.8 Categorywise Distribution of Industries

S.No.	CATEGORY	Total No. of Units
1	ALUMINIUM	7
2	CAUSTIC	25
3	CEMENT	116
4	COPPER	2
5	DISTILLERY	177
6	DYES & D.I.	64
7	FERTILIZER	110
8	IRON & STEEL	8
9	LEATHER	70
10	PESTICIDE	71
11	PETROCHEM	49
12	PHARMA	251
13	PULP & PAPER	96
14	REFINERY	12
15	SUGAR	392
16	TPP	97
17	ZINC	4
	TOTAL	1551

Table2.9 : **STATEWISE SUMMARY STATUS OF THE POLLUTION CONTROL IN 17 CATEGORIES OF INDUSTRIES** (as per the information available on 31st march 2000)

STATE/UT	Total No. of Units	Status (No. of Units)		
		Closed	C#	Defaulters ##
Andhra Pradesh	173	29	142	2
Arunachal Pradesh	0	0	0	0
Assam	15	2	11	2
Bihar	62	17	35	10
Goa	6	0	6	0
Gujarat	177	7	168	2
Haryana	43	4	36	3
Himachal Pradesh	9	0	9	0
Jammu & Kashmir	8	3	5	0
Karnataka	85	9	70	6
Kerala	28	6	20	2
Madhya Pradesh	78	9	60	9
Maharashtra	335	24	300	11
Manipur	0	0	0	0
Meghalaya	1	0	1	0
Mizoram	0	0	0	0
Nagaland	0	0	0	0
Orissa	23	1	15	7
Punjab	45	6	39	0
Rajasthan	49	6	43	0
Sikkim	1	0	1	0
Tamil Nadu	119	2	117	0
Tripura	0	0	0	0
UT - Andman & Nicobar	0	0	0	0
UT - Chandigarh	1	0	1	0
UT - Daman & Diu, Dadra & Na	0	0	0	0
UT - Delhi	5	1	3	1
UT - Lakshadweep	0	0	0	0
UT - Pondicherry	6	1	5	0
Uttar Pradesh	224	21	198	5
West Bengal	58	16	35	7
TOTAL	1551	164	1320	67

Table 2.10: CATEGORYWISE SUMMARY STATUS OF THE POLLUTION CONTROL

Category	Total No. of Units	Status (No. of Units)		
		Closed	Adequate pol	Defaulters
Aluminium	7	1	6	0
Caustic	25	0	25	0
Cement	116	8	108	0
Copper	2	0	1	1
Distillery	177	29	130	18
Dyes and Dye intermedia	64	8	56	0
Fertilizer	110	10	97	3
Iron & Steel	8	0	2	6
Leather	70	11	59	0
Pesticide	71	7	63	1
Petroleum	49	0	49	0
PHARMA	251	26	225	0
Pulp & Paper	96	19	75	2
Refinery	12	0	12	0
Sugar	392	43	334	15
Thermal power plant	97	2	74	21
Zinc	4	0	4	0
TOTAL	1551	164	1320	67

2.11. Categories of Bio-medical waste

	Waste Category	Treatment and Disposal
y No. I	**Human Anatomical Waste** (human tissues, organs, body parts) incineration@/deep burial*	incineration@/deep burial*
y No. 2	**Animal Waste** (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospitals, animal houses)	incineration@/deep burial*
y No. 3	**Microbiology and Biotechnology Waste** (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological toxins, dishes and devices used for transfer of cultures	local autoclaving / micro-waving / incineration@
y No. 4	**Waste sharps** (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	disinfection (chemical treatment@01/auto claving / micro-waving and mutilation/ shredding
ry No. 5	**Discarded Medicines and Cytotoxic drugs** (wastes comprising of outdated, contaminated and discarded medicines)	incineration@/destruction and drugs disposal in secured landfills
ry No. 6	**Solid Waste** (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	incineration@ autoclaving / microwaving
ry No. 7	**Solid Waste** (wastes generated from disposable items other than the waste shap such as tubings, catheters, intravenous sets etc.)	disinfection by chemical treatment@@ autoclaving / microwaving and mutilation/ shredding##
ry No. 8	**Liquid Waste** (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities)	disinfection by chemical treatment@@ and discharge into drains.
ry No. 9	**Incineration Ash** (ash from incineration of any bio-medical waste)	disposal in municipal landfill
ry No. 10	**Chemical Waste** (chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)	chemical treatment@@ and discharge into drains for liquids and secured landfill for solids

Chemicals treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.
Iutilation/shredding must be such so as to prevent unauthorised reuse.
here will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated.
ep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

Table 2.12 : Status of Hazardous Waste Generation

State	No. of Units Generating HW	Quantity of Waste Generated (Waste Type) TPA		
		Recyclable	Incinerable	Disposable
Andhra Pradesh	501	61820	5425	43853
Assam	18	-	-	166008
Bihar	42	2151	75	24351
Chandigarh	47	-	-	305
Delhi	-	-	-	-
Goa	25	873	2000	3725
Gujarat	2984	26000	19953	150062
Harayana	309	-	-	31046
Himachal Pradesh	116	-	63	2096
Karantaka	454	47330	3328	52585
Kerala	151	84932	5069	690014
Maharashtra	3953	847436	5012	1155398
Madhya Pradesh	183	89593	1309	107767
Orissa	163	2841	-	338303
Jammu and Kashmir	57	-	-	-
Pondicherry	15	8730	120	43
Punjab	700	9348	1128	12233
Rajasthan	306	9487	19866	2242683
Tamil Nadu	1100	193507	4699	196002
Uttar Pradesh	1020	-	-	-
West Bengal	440	45233	50894	33699
Total	12584	1429281	118941	5250173

* Total of recyclable, incinerable and disposable will not add up due to waste sold or otherwise disposed

Table 2.13 : **Sources and Quantum of Waste Generated from Major Industrial Sources**

Waste	Quantities MTPA 1990	Quantities MTPA 1999	Source/Origin
Steel and blast furnace sl	35	7.5	Conversion of pig iron to steel and manufacture of iron
Brine mud	0.02	-	Caustic soda industry
Copper slag	0.02	-	By-product from smelting of copper
Fly ash	30	58	Coal based thermal power plants
Kiln dust	1.6	-	Cement plants
Lime sludge	3	4.8	Sugar, paper, fertiliser, tanneries, soda ash, calcium carbide
Phosphogypsum	4.5	11	Phosphoric acid plant, ammonium phosphate
Red mud/bauxite	3	4.0-4.5	Mining and extraction of alumina from bauxite
Lime stone	-	50	-
Iron tailings	-	11.25	-

Table 2.14 Mining waste (coal overburden removal) in the mechanized opencast mines (million cubic metres) in the Coal India Limited

Company	*1975/76*	*1980/81*	*1985/86*	*1990/91*	*1991/92*	*1992/93*
Eastern Coalfields Ltd	2.5	8.4	16.8	20.7	16.5	20.1
Bharat Coking coal Ltd	0.7	4.6	16.3	28.4	31.0	33.7
Central Coalfields Ltd	10.8	32.8	32.4	48.4	52.1	52.2
Northern Coalfields Ltd	-	-	28.0	89.4	89.1	83.0
Western Coalfields Ltd	7.3	16.9	22.9	35.7	41.3	44.8
South-Eastern Coalfields Ltd	-	-	30.1	60.2	65.4	48.2
Mahanadi Coalfields Ltd	-	-	-	-	-	23.6
North-Eastern Coalfields Ltd	-	-	2.9	1.1	3.8	4.0
Total	21.3	62.7	149.5	284.0	299.2	309.6

Source

CIL 1993 ***Operational Statistics***. p. 43. Calcutta: Coal India Limited.

Table 2.15 Municipal solid waste generation (kg per capita per day)

City	*1971-73*	*1986/87*	*1994*
Ahmedabad	0.24	–	0.59
Ajmer	0.24	0.44	–
Allahabad	0.20	0.50	–
Aurangabad	0.42	0.67	–
Bangalore	0.32	–	0.48
Baroda	0.29	–	0.39
Bhopal	0.26	–	0.51
Bikaner	0.29	–	–
Calcutta	0.50	–	0.34
Chandigarh	0.36	–	–
Chennai	0.32	–	0.66
Coimbatore	0.31	–	0.43
Delhi	0.21	–	0.48
Gorakhpur	0.21	0.64	–
Guwahati	0.24	–	–
Gwalior	0.27	–	–
Howrah	0.59	–	–
Hyderabad	0.33	–	0.40
Jabalpur	0.30	–	0
Jaipur	0.28	–	0.40
Jodhpur	0.20	0.45	–
Kanpur	0.55	–	0.64
Kochi	–	0.27	0.52
Kota	0.25	0.40	–
Kozhikode	0.15	0.16	–
Kurnool	0.20	–	–
Lucknow	–	–	0.62
Ludhiana	–	0.40	0.40
Madurai	0.38	–	0.39
Mumbai	0.49	–	0.44
Nagpur	0.22	–	0.27
Patna	0.48	–	0.36
Pune	0.24	–	0.31
Raipur	0.32	0.23	–
Rajkot	0.07	0.21	–
Sangli	0.23	0.30	–
Surat	0.15	–	0.60
Tatanagar	0.45	–	–
Thane	0.23	–	–
Tiruchirapalli	0.21	–	–
Thiruvananthapuram	0.12	0.34	–
Udaipur	0.14	–	–
Vadodara	–	–	0.39
Varanasi	–	–	0.40
Vijayawada	0.17	0.44	–
Vishakhapatnam	–	0.31	0.40

Sources

1 INSDOC. 1983. ***Solid Waste Management in Developing Countries***. New Delhi: Indian National Scientific Documentation Centre.

2 NIUA. 1989. ***Upgrading Municipal Services: Norms and Financial Implications.*** New Delhi: National Institute of Urban Affairs.

3 EPTRI. 1995. ***Status of Solid Waste Disposal in Metropolis***. Hyderabad: Environmental Protection Research and Training Institute.

4 CPCB. 1999. ***Status of solid waste generation, collection and disposal in metrocities***. New Delhi: Central Pollution Control Board [Central Urban Pollution Series: cups/46/1999/2000 (for 1994)]

Table 2.16 : Physico-chemical characteristics of MSW

Component	% of wet weight	
	1971-73† (40 cities)	1995‡ (23 cities)
Paper	4.14	5.78
Plastics	0.69	3.9
Metals	0.5	1.9
Glass	0.4	2.1
Rags	3.83	3.5
Ash and fine earth	49.2	40.3
Total compostable matter	41.24	41.8
Calorific value (kcal/kg)	800-1100	<1500
Carbon-nitrogen ratio	20-30	25-40

† Bhide and Sundaresan 1983
‡ EPTRI 1995

Table 2.17. Status of Municipal Solid Waste Treatment and Disposal in metrocities

City	Solid waste collection (tonnes/day)	Treatment (tonnes/day)	Mode of disposal (%)		
			Dumping	Composing	others
Ahmedabad	1,683	84	95	5.0	–
Bangalore	2,000	200	90	10.0	–
Bhopal	546	100	82	18.0	–
Calcutta	3,692	–	100	–	–
Chennai	3,124	–	100	–	–
Coimbatore	350	–	100	–	–
Delhi	4,000	300	93	7.5	–
Hyderabad	1,566	100	94	6.0	–
Indore	350	50	86	14.0	–
Jaipur	580	–	100	–	–
Kanpur	1,200	300	75	25.0	–
Kochi	347	–	100	–	–
Lucknow	1,010	–	100	–	–
Ludhiana	400	–	100	–	–
Madurai	370	–	100	–	–
Mumbai	55,355	500	91	9.0	–
Nagpur	443	–	100	–	–
Patna	330	–	100	–	–
Pune	700	50	93	–	7
Surat	900	225	75	25.0	–
Vadodara	400	100	75	–	5
Varanasi	412	–	100	–	–
Vishakhapatnam	300	–	100	–	–

Source

CPCB. 1999. ***Status of solid waste generation, collection and disposal in metrocities.***
New Delhi: Central Pollouton Control Board [Central Urban Pollution Senes: cups/46/1999-2000.]

Table 2.18 Technologies for municipal solid waste treatment and disposal

Technology	Percent market share %
Composting	50
Anaerobic biodigestion (Biomethanation)	30
Pellatization	10
Sanitary Landfill	10

Table 2.19 Municipal Solid Waste treatment and disposal technologies - Best Sales prospect

Technology	market potential (US $ million)				Sales prospects
	1997	1998	1999	2000	
Composting	135	155	179	205	H
Biomethanation	81	103	131	166	H
Sanitary landfill	27	34	42	53	L
Pelletization	27	32	39	47	L
Incineration	-	-	-	-	L
Total	270	324	391	471	

source: Pradeep dadlani, Sycom projects,
report done for U S & Foreign commercial services and U.S department of State, 1998.